THE RUBBER INDUSTRY

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THE RUBBER INDUSTRY.

BEING THE OFFICIAL REPORT OF THE PROCEEDINGS OF THE INTERNATIONAL RUBBER CONGRESS, LONDON, 1911, HELD AT THE INTERNATIONAL RUBBER AND ALLIED TRADES EXHIBITION, 24th JUNE TO 14th JULY.

EDITED BY

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AND

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Dedicated to

SIR HENRY A. BLAKE, G.C.M.G.

in high appreciation of his

services, so ungrudgingly rendered,

as President of the

Second International Rubber Exhibition.

PREFACE.

THIS volume represents the papers presented at the Conferences of the 1911 Exhibition. Some were read and discussed; others were taken as read. The discussions were in most cases very thorough and profitable, and in arranging them for printing, only the fewest possible changes have been made in the stenographers' notes.

It has been thought best to carry over to this volume the Introductory Article written by Dr. Spence for the first volume, and the tables given at the end of the same article have been printed without change. Such changes as would be required after three years seemed to the Editors hardly worth while. Another three years may see more changes.

The Management of the Exhibition wish to place on record their appreciation of the great service rendered to the Rubber Industry and the Exhibition by the gentlemen who took part in the Conference.

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Royal Agricultural Hall, London.

24th JUNE to 14th JULY, 1911.

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CHAPTER I.

Opening of the Conference.

Introduction—Historical and Descriptive.

OPENING OF THE CONFERENCE.

MONDAY, 3RD JULY.

ADDRESS BY THE PRESIDENT.

The Conference opened on Monday, July 3rd, under the presidency of the President, Sir Henry A. Blake, with a large attendance. Among those present were :—

Dr. J. B. de Lacerda, Dr. Paul Alexander, Mr. J. de Argôllo, Junr., Mr. T. Petch, Prof. Dr. E. de Wildeman, Monsieur André Cremazy, Prof. P. Carmody, F.I.C., F.C.S., Dr. Tromp de Haas (Java), Dr. Fritz Frank (*Scientific Chemist*, Berlin), Mr. G. Springer (Editor, *Gummi-Zeitung*, Berlin), Dr. Ernst Stern, Dr. Ludwig Sachs, Senor Emilio Castre (Peru), Mr. Arthur Schopper, Mr. B. Rechtnitz (Budapest), Monsieur Brémant (Paris), Mr. Leonard Wray, I.S.O., Mr. J. A. Richardson (South India), Dr. Werner Esch, M.A.L. (Editor, *Gummi-Markt*, Berlin), Monsieur Francois, Dr. Paul Preuss, Dr. J. Huber, Monsieur R. Ehrhardt, Mr. Fr. Hupfeld, Mr. H. Hamel Smith (Editor, *Tropical Life*, London), Mr. Max Hardt, Mr. John Pavott, Dr. R. Stern, Monsieur Paul Osterrieth (Antwerp), Herr Dr. Memmler, Dipl.Ing., Mr. A. Pahl, Prof. Dr. F. W. Hinrichsen, Mr. J. G. Fol, Mr. H. Powell (East Africa Protectorate), Mr. J. Ewart Barbary, Mr. Edward F. Pfaff (*India Rubber World*), Mr. F. Alves Vieira (Consul General for Brazil), Mr. R. Fyffe (Uganda), Mr. R. Baird, Mr. W. Martin, Mr. P. Poogerie, Monsieur A. Cillard, Mr. O. Dinglinger (Berlin), Mr. H. S. Smith (Tobago), Philip Schidrowitz, Ph.D., F.C.S., Mr. Herbert Wright, A.R.C.S., F.L.S. (Editor *India Rubber Journal*), Mr. P. Rix Gelada, Mr. D. S. Hunter, Mr. A. Whalley, Mr. J. Mitchell, A.R.C.Sc., Mr. N. Frendenberg, Mr. M. Fischer, Dr. Wo. Ostwald, Mr. Clayton Beadle (London), F.R.Met.Soc., Mr. H. A. Wickham, Mr. W. G. Millen, Mr. F. A. Stockdale, B.A., F.L.S. (British Guiana), Mr. W. S. D. Tudhope (Gold Coast), Mr. A. F. Suter, Dr. J. Torrey, Mr. S. Berk, Mr. E. Lierke (Berlin), Mr. H. M. Will, Mr. Hubert L. Terry, Mr. V. Lommel, Mr. F. Stern, Mr. A. C. Paupe, Mr. E. W. Graves (Boston, U.S.A.), Dr. Henry P. Stevens, M.A., F.I.C., Mr. H. Hallen, Prof. Dr. O. Warburg (Berlin), Mr. Edgar Warburg, Mr. S. Frendenberg (Colombo), Mr. J. Maxwell Ridenig (Liverpool), Mr. W. H. Cochrane, Dr. Denidse, Dr. Weil (Hannover), Mr. Victor Hamel Smith, Mr. D. Sandman, Monsieur O. Dupuy, Monsieur Auguste Chevalier, D.Sc., Dr. C. Christy, Mr. Walter A. Voss, Mr. C. Ladewig, Miss A. T. Borrowman, Mr. Herbst (Vienna), Mr. C. V. Moor, Mr. A. Staines Manders (Organising Manager).

Sir HENRY BLAKE said: In opening the proceedings at the exhibition held at Olympia in 1908 I welcomed the foreign delegates and growers to our shores. To-day, in bidding you welcome, ladies and gentlemen, I do so with both hands extended to old friends and with an assurance that the proceedings of 1908 have borne good fruit in all branches of the rubber industry. Of this ample proof is afforded by the exhibits under this roof to-day, where it may be broadly stated that every rubber growing country in the world has sent its representatives and its products, while on this side the machine makers have sent their improved machinery. The chemists have illustrated the results of their researches into the

analysis of rubber, and the manufacturers have shown expansion of their cunning adaptation of the raw material to new uses.

When we last met, the area planted with rubber in the Middle East was about 450,000 acres. The present acreage is more than double that figure, while South and Central America and East and West Africa show increases probably in equal proportion. But in estimating the probable output of the increased acreage it will be necessary to allow for considerable deduction on account of plantations established under unsuitable conditions of situation, soil or climate. In the most favourable circumstances Para trees planted since 1908 cannot be expected to come into full bearing before 1913 at the earliest, and we must wait at least two years longer before we shall begin to know the returns from the very large investments in new plantations made last year. In the meantime the continuous experiments and experience gained since last we met must be of benefit to the new plantations, and the papers to be read and discussed during our present meeting will remain a valuable asset for all branches of the rubber industry.

Up to the present the planter has pinned his faith mainly on the *Hevea Brasiliensis* or Para rubber tree, but the some-time despised *Manihot Glaziovii* or Ceara tree is, if my information be correct, about to have its vogue. I have heard from a reliable source of at least one Ceara plantation that has begun to yield its harvest at two years' growth, while great improvements have been made in its tapping, which is quite a different problem from the treatment of the *Hevea Brasiliensis*. These are matters for the bronzed experimenter in field work who faces the discomforts and diseases incidental to tropical life in the field and the jungle : but he only starts the quarry. When he has produced the latex it is taken in hand by the chemist and tortured through a series of retorts until it has answered all sorts of questions as to its likes and dislikes—its attractions and repulsions—until the reasons for its resiliency and tenacity are exposed, while some of these silent workers, flinging the latex aside and abandoning themselves to a fury of investigation, have torn the very vitals from the secrets of Nature, and smilingly present us with a row of bottles and a small sheet of rubber which is, they assure us, capable of indefinite expansion. Well, when some of these wizards present us with milk and butter direct from a bundle of hay we may rest assured that the price of hay will go up. And we may assume that the same law will govern the price of materials for synthetic rubber. The demonstrated possibility of producing a synthetic rubber should, however, emphasise the necessity of strict economy, and in aiming at reduction in the cost of production of plantation rubber.

I congratulate the exhibitors upon the elegance and completeness of their various courts. Where all are good, I may perhaps mention the improvement over the last exhibition shown by the Netherlands, Germany, Ceylon and Malay States, and welcome the West Indian Islands, in which rubber is evidently a coming product ; but all will join with me in a warm appreciation of the beautiful court created by Belgium out of what seemed to me before its erection an unfavourable and somewhat dark position. We have heard with much interest the paper on reforms in the Belgian Congo, presented by Monsieur Wendelen on Friday last, and, apart from rubber exhibits, examining the court, from that fine and pathetic sculpture group of the Arab slave dealer and his victims to the pictures of the missionary schools, we rejoice to hear that, thanks to the young King, who before his accession had the energy to travel, the eye to see, and the heart to pity, the Belgian

people have learned the facts of the dark conditions existing in the African under-world and determined that they shall be changed, and the wretched survivors of long years of desolation have begun to look up and find that the God of Mercy lives and promises freedom and justice in the future. Therefore it is that we accept with heartiest good wishes their products for competition in our markets.

There is no greater solvent of international jealousies or misunderstandings, or stronger cement of friendships than the co-operation for a common purpose, and in looking over the rubber industry as exemplified in this exhibition and so ably represented by delegates from every portion of the tropical belt, it is a happy consideration that we are a truly international body of co-operators, among whom no note of discord is heard, each intent upon unreservedly adding to the common stock the information that he has acquired, and each noting the improvements effected elsewhere by which he may profit on his return. You will have seen that prizes have been offered in different branches affecting the industry. I regret that our friend Mr. Pearson, of the *India Rubber World*, who generously presents one of them, is prevented from being with us. I am sure that no colleague in the work of the exhibition would have been more warmly greeted by his many friends.

I will not further trespass upon your time. Once more for myself and on behalf of the Committee, I greet you most heartily and bid you welcome.

I hope we shall be able to adjourn by 12 o'clock until after luncheon, as Her Highness Princess Marie Louise of Schleswig Holstein is coming to visit the exhibition, and I am anxious to be able to take Her Highness round, where probably she will meet some of the delegates in their courts. With regard to the papers that are to be read, you will see from the printed slips that the descriptive, historical and general papers are to be first taken. Then to-morrow will be taken papers on the cultivation and botanical side, that is, planting, weeding, and tapping of trees, questions of yield and costs, growth and plant sanitation, insect and fungus pests ; soils, labour, manures, etc. Those are very important matters, and I trust that in the consideration of these matters as they come before you the papers will be listened to with the same patience and discussed with the same keen insight into the papers in all their bearings, as we experienced at the exhibition in 1908, when so many valuable papers were read by the able supporters of the first rubber exhibition. Mr. Manders wishes me to tell you that a photograph of those attending the Conference will be taken at 12 o'clock. Now, I invite any suggestions as to papers that may be read or questions that might be discussed to-day, when we meet again after luncheon. You will understand that what we want is a general discussion on any subject connected with the exhibition and the industry that may strike you.

Mr. Richardson : With a view of starting the discussion I should like to mention one matter which would be of much use to the planters present here. Being a planter myself, I should be very glad if there is any manufacturer here who could give us some sort of an idea as to what particular form of rubber they would like us to make in the East. It is a point of very great interest to us.

The President : If we have any manufacturer present, he might give us the information.

Mr. Manders : I might mention that the manufacturers are coming here to meet the planters on Thursday and Friday this week to answer

any question they possibly can. Unless there is a manufacturer present who can answer the questions now they can be left for those days, but to-day is left for discussions on general subjects and for suggestions in reference to getting further papers ready that have not yet been arranged for, or for the discussion of any subject not mentioned on the printed slips. Gentlemen have at different times asked me whether certain questions can be discussed and I asked them to attend to-day and raise the question.

No further suggestions being made, the Conference adjourned to the afternoon.

Introduction—Historical and Descriptive.

By Dr. D. SPENCE.

The word india-rubber, which is still almost exclusively used in English, was first applied to that substance which the Indians on the banks of the Amazon called *cahuchu*. This substance was found by the great English scientist Priestley, in 1772, to have the power of removing pencil marks from paper, and as this was for long almost the only, if a not unimportant, use to which the substance was put, it is perhaps not surprising that the word india-rubber, however ugly, found access to our language and has been generally accepted.

The word caoutchouc (the "Kautschuk" of the Germans) on the other hand, which is obviously derived from the native name, was also introduced to denote the same elastic substance as india-rubber, but this word has only found a limited application in England, although in other countries it is almost the only one in use. In England the word caoutchouc has come to be looked upon as rather denoting the pure product, while india-rubber is a general term for the substance, whether raw or manufactured.

There is almost no natural product on the market to-day in such quantity about which less appears to be known. We hear, for example, from time to time of the production of this substance (synthetic rubber) from products so different chemically from india-rubber that we are led to the conclusion that the would-be inventor had not even the remotest idea of the nature of the substance which he set out to prepare, and on the other hand, even the large dealer in india-rubber himself is not infrequently guilty of classing india-rubber, resins and gums, as resins or gums indiscriminately together.

For those, therefore, whose interest in the subject of india-rubber is general rather than specialised or scientific, a short account of what rubber is may not be unwelcome. It must be understood, however, that it is quite impossible in a few notes to do justice even to one small branch of this very important subject.

Those who have already advanced in their knowledge of the subject of raw india-rubber are advised to pass over these introductory notes, and to seek their information from the reports on the various lectures held during the Exhibition season, which are published in full in this work. Even the most zealous specialist in this subject cannot fail to find there material suited to his taste, so numerous are the subjects discussed.

The first European to become acquainted with india-rubber or caoutchouc appears to have been Christopher Columbus. At all events,

Antonio de Herrera, the historian, states of him that on his second voyage of discovery to America in the years 1493–1496, he saw the inhabitants of Haïti playing with balls which he afterwards learned were prepared from *gum from a tree*. Before Herrera, however, in 1535, Gonzalo Fernandez de Oviedo y Valdez reported on elastic balls which the Indians used in their games, and even ten years before this Pietro Martyr d'Anghiera had introduced india-rubber into our literature without, however, naming it. In the year 1615 Juan de Torquemada issued a report in regard to a tree from which the inhabitants of Mexico extracted a milky liquid which the Spanish invaders afterwards used to make their garments water-tight. It would take one too far afield, however, to trace down the various reports published from time to time in regard to this curious product, which gradually became better known in our country as india-rubber and for which several uses were soon suggested by practical men. It was not, however, until after the important discovery of vulcanisation by Goodyear that india-rubber came to be looked upon as a natural product of great commercial value, and that a means of utilising it became known. Indeed, it may safely be said that but for the discovery of vulcanisation the india-rubber industry would never have risen to be what it now is.

The india-rubber of commerce is derived from the milky secretion known as latex of certain tropical and sub-tropical trees, creepers and shrubs found chiefly in America, Africa, and in the Indo-Malay regions. When these rubber-yielding plants are injured by excising the bark or by tapping, as it is called, or in some such way, a more or less thick milky-looking fluid is found to exude from certain parts of them. This fluid which resembles milk probably more closely than has been hitherto believed, varies in density with the source from which it is collected and still more with the amount of caoutchouc contained in it. The density of latex is usually less than that of water on account of the caoutchouc contained in it, the specific gravity of which is considerably less than one.

The latex when examined under the microscope is seen to be composed of a very minute oil-like refractive globules, varying in size, which are in a state of rapid Brownian movement in a clear transparent liquor known as the serum. When sections of the latex-producing plant are also prepared and examined under the microscope one finds in general that the latex is confined to certain well-defined but peculiar canal-like structures known as latex vessels which run in a perfectly definite way throughout certain parts of the plant, although the arrangement or distribution of these latex tubes may vary very considerably in different plants. It is hardly necessary, therefore, to point out how much of the success in the "tapping" of rubber trees will depend on the rational application of scientific information in regard to the distribution of the latex system in the plant.

When we turn, now, to study the latex itself we find ourselves face to face with an interesting but complicated subject. When properly collected the latex should be entirely free from such impurities as bark, vegetable fibre and sand, which one so often finds in rubbers prepared from some latices by the primitive methods of the natives themselves. The latex of the various rubber-producing plants is usually stated to be neutral or faintly alkaline, sometimes it has been said to be acid, but the correctness of this assertion is doubtful. Probably it is amphoteric, or faintly alkaline, like most physiological fluids involved in metabolic processes, and on the maintenance of this reaction may depend its whole

usefulness in the economy of the plant. In vitro, however, the reaction of the latex quickly changes. The latex develops acidity on standing, due to the presence in it of certain bodies known as enzymes, which are characteristic of all living cells, and which undoubtedly play an important *rôle* in all vital processes. These enzymes in the latex not only produce the acidity which develops in latex on standing, which results in the coagulation of the latex as a rule, but they also account for many of the phenomena occurring in the raw india-rubber of commerce (the darkening in colour and perhaps the "heating" of raw rubber, for example), and may serve to explain the function of the caoutchouc in the plant and the way in which the caoutchouc may be utilised by the plant. The old accepted theory whereby the caoutchouc was looked upon as an excretory product of plant metabolism has recently been thrown in doubt on account of the presence of oxidising-enzymes in association with the caoutchouc in the latex and in the rubber therefrom.

When the latex is submitted to chemical examination one finds that it is not merely an emulsion of fine particles of caoutchouc in water. Every latex which yields rubber may be said to contain, besides the caoutchouc globules which give the latex its milky appearance, other chemical substances, such as resins and protein, the distribution of which in the latex is not yet known, and organic substances such as sugars, glucosides, salts of acids such as malic acid, along with varying quantities of inorganic salts such as sulphates, phosphates and chlorides, all of which are dissolved in the watery mother-liquor. In this connection the presence of active enzymes, which has been recently recorded in this latex, must also be noted, as they are probably of fundamental significance, both physiologically and commercially.

The amount of caoutchouc and other substances which can be got from a given quantity of latex depends on the source of the latex, on the age of the tree from which it is collected, and on the part of the tree from which the latex is taken, as well also as on the external conditions affecting the metabolism of the tree. In the same way the amount of latex collected from a tree depends on a great many factors at present beyond our control. Obviously, therefore, a very great many factors must be taken into account if we are to collect useful and reliable data in regard to the "bearing capacity" of a rubber tree. This is only too frequently overlooked.

India-rubber is the dried-up or coagulated latex. The methods employed at the present time for the coagulation of latex are very numerous and often very rough. It is worth pointing out here that although the true caoutchouc of the latex may not be and probably is not the same in the physico-chemical sense in all latices, that the method of coagulation has nevertheless a very important bearing on the physical properties of the resulting rubber. By scientific methods of collection and coagulation of the latex there is but little doubt that the quality and the value, therefore, of the poorer brands of rubber could be very much raised.

It is impossible to enter here into an account of the current views in regards to latex-coagulation. This subject is much too complicated a one to admit of treatment in such a review as this. Special articles are devoted to this subject which those interested should study, but as the subject of the coagulation of the latex is of great importance from the practical side it may not be out of place to outline here the methods of coagulation employed in various parts of the rubber-producing world, and to give a short account of some of these.

METHODS OF COAGULATION.

1.—By heat.

(*i*) By artificial heat.

(*a*) Dry heat or smoking: On the Amazon, Brazil, in New Caledonia.

(*b*) Most heat or boiling: In Mexico and in West Africa for *Funtumia elastica* and *Landolphia* latices.

(*ii*.) By natural heat.

(*a*) Separation by the soil: In Angola.

(*b*) Separation by human body: In Congo, Angola, etc

(*c*) Evaporation on level ground: In Ceara, Angola.

2.—By skimming.

(*a*) Skimming after the addition of water, draining, washing, and pressing: In Bahia, Congo.

(*b*) Skimming by mechanical or centrifugal means, combined with coagulation by means of acid: In experimental stage in Ceylon and F.M.S.

3.—Coagulation by chemical means.

(*a*) Mineral acids and mineral reagents: In Gambia, Senegal, Mozambique, Matto Grosso, Pernambuco, Maranhao.

(*b*) Organic acids and extracts of plants, etc.: In Ceylon,and F.M.S., also Peru, Gautemala, Gambia, Madagascar. Upper Congo, etc.

4.—By beating and maceration: For *Landolphia* and other root rubbers —West Africa and German East Africa and Madagascar. In Mexico for "Guayale" rubber.

5.—By maceration and extraction with solvents for the caoutchouc: For "Guayule" rubber in Mexico and elsewhere.

1 (1a).—Coagulation by means of Artificial and Dry Heat or Smoking.

This method, although one of the oldest, seems to be especially suitable for the Heveas and Micrandras, and it is mainly in use for the preparation of Para rubber on the Amazon, although it has also been employed in other parts of Brazil, and has been adopted in Venezuela and Guiana. It can still be described as the method by which the best caoutchouc on the market is obtained.

The latex, collected in cups from incisions made in the bark of the tree is poured into a pail or a large gourd bottle, and the empty cups are replaced in the positions from which they were taken. When the whole of the latex has been collected, it is brought to the hut of the native, where a fire is lit in a fireplace which has been scooped out of the gróund. On the lower Amazon the fruits of the Urucuri or of the Naussu palm (*Atalea excelsa* and *Manicaria saxifera*) are added to the faggot fire, which increase the thickness of the smoke.

As soon as sufficient smoke has developed, the cauchero takes the pallette, a wooden instrument with a handle 3 to 6 ft. long and holds the broad flat end of this form over the smoke for a moment, dips it then into the pail containing the latex, and back again into the smoke in order to coagulate the latex which has adhered to it. This process is repeated until the caoutchouc layers have become sufficiently thick, when the lump of raw rubber is then cut off, dried for several days, and despatched, usually as "fine Para biscuits," to the nearest trading centre. It is believed that the smoke from the palm nuts possesses valuable antiseptic properties, on account of the presence in it of small quantities of creosote and other substances, and it is highly probable that

the excellent quality of Para rubber is due as much to the method of its preparation as to the exceptional properties of the latex from which it is prepared.

Para entrefine, Negro Heads, Sernamby, are but less pure varieties of fine Para, prepared usually from the rubber which adheres to the tree during tapping and to the vessels containing the latex.

1 (1b).—Coagulation by means of Moist Heat or Boiling.

This is a primitive method employed by the Indians in Mexico to coagulate *Castilla* latex, and it is extensively used in West Africa for the latex from *Funtumia elastica*. The latex, which is collected in a piece of bark or in a pot, is passed through a sieve into a boiler under which a faggot fire is lit. The raw caoutchouc slabs obtained by collecting the separated caoutchouc and squeezing it into slabs is of inferior quality. The method has many grave defaults, and in recent years Mexican rubber has been improved in colour and odour by improved methods of treatment.

Boiling the latex has also been carried out in British India, and the preparation of the latex from *Ficus elastica*, which gives the Assam caoutchouc, is done in the same way.

1 (2a).—Coagulation by Natural Heat.

Coagulation by natural heat is still in use in East and West Africa, where the negroes tap the trees regardless of the effect of the cutting. The latex flows on the ground, where it coagulates, the water disappearing by evaporation and absorption. Several tribes on the Congo and elsewhere collect *Landolphia* rubber in this way, and the product is consequently of very inferior quality.

1 (2b).—Coagulation by Natural Heat. Evaporation on the Human Body.

This method is also in vogue amongst the African natives. The negro when tapping the lianes collects the latex in the hollow of his hands. He then smears the material over his body, and as soon as it has dried it is torn off in shreds and rolled into balls. Dr. Welwitsch states that several Angola tribes use the same method.

1 (2c).—Coagulation by Natural Heat—on other Surfaces than the Soil.

Brazil is the home of this method, which is used for making Ceara caoutchouc. (Ceara scraps) from the latex of *Manihot glaziovii*. The process is also known in West Africa and in India.

In Ceara the tree is tapped when about three years old, and the ground is covered with banana leaves to collect the dripping latex. Cuts are made from the bottom upwards to a height of about six feet in all directions, and the latex of *Manihot*, being much thicker than that of the Heveas of Castillas, runs very slowly, and only infrequently flows to the ground. The coagulated caoutchouc is stripped off the tree, collected, and rolled into balls. Ceara caoutchouc prepared in this way contains a large quantity of mineral and vegetable material, which detract from its value, and is not, therefore, surprising that better methods of coagulation for *Manihot glaziovii* have been adopted with success in other parts—German East Africa, Ceylon, etc.

2 (a).—Coagulation by Skimming after Dilution with Water.

This method is used in connection with the latex from *Hancornia*, and on the Congo for coagulating the latex from *Landolphia*. It has also been used in Bahia, in several places near Nicaragua, in Central America for the *Castilla* latex, and in Assam, where the latex of *Ficus* is

prepared. In short, the mixed latex and water are allowed to stand quiescent for a time. The caoutchouc rises to the surface, is taken off, kneaded until it becomes compact, and partially dried. In this form it is put on the market, or it is cut up into small squares or "thimbles." The method yields inferior products, and much better results have been obtained for Landolphias by other methods of treatment. The raw rubbers obtained in this way all contain too much moisture, in addition to uncoagulated latex. Fermentation soon makes itself evident by its characteristic and obnoxious odours. Partial washing of the raw product is sometimes undertaken, but the product is spongy, with many holes containing putrescent mother liquor. The loss on washing of rubbers prepared by this method is very great.

2 (b).—Skimming by Mechanical or Centrifugal Means.

This method is not much more than in its experimental stages yet. The separation of the caoutchouc particles is effected by means of centrifugal force. The method has been tried in some rubber estates, but without much success. It is doubtful if the latex from *Hevea braziliensis* can be dealt with effectively by this method. Centrifugalisation, however, is used as a quick means of separating the caoutchouc after agglutination by means of acid.

3.—Coagulation by Chemical Means.

(*a*) *Mineral Acids and Inorganic Salts.*

In Maranhoa and Matto Grosso sulphuric acid has been used for the rapid coagulation of the latex, and is still in use, but results obtained by means of it are not very satisfactory. Sea salt has, however, largely taken the place of sulphuric acid in the two provinces which formerly used the acid. Several African rubbers, such as those from the Ivory Coast, Cameroons, and the Congo are prepared by treatment with salt water In some parts the incisions in the lians are brushed with salt water, and the coagulated caoutchouc is drawn out and wound into a solid ball. Alum also acts as a powerful coagulant, and is used in Pernambuco and Maranhoa for the coagulation of *Hancornia* latex. The rubber prepared by the addition to the latex of a solution of alum deteriorates rapidly, and unless the product is washed thoroughly free from alum it very soon becomes of little market value.

In Peru, *Hancornia* latex is also coagulated by means of soap suds. The soap solution is mixed with the latex, and the whole is beaten by hand to facilitate coagulation.

Other inorganic reagents, such as iron trichloride, corrosive sublimate, calcium chloride, have been recommended as coagulants, but it is doubtful if they are employed in practice.

(*b*) *Organic Acids and Extracts of Plants, etc.*

This includes a great variety of coagulants and coagulation methods, and into each it is impossible to go. In Ceylon and the F.M.S. the latex from *Hevea brasiliensis* is coagulated by the addition to it of dilute acetic acid, or acetic acid with alcoholic creosote. This latex is alkaline to litmus, and just enough acid is added to render it faintly acid. The caoutchouc separates rapidly after acidifying. This method of coagulation has been well studied, and it is being applied in other parts.

Many African latices are coagulated by the addition to them of watery extracts of the leaves or stems of certain plants. Coagulation is usually brought about by the acid juices extracted from the plants. "Ofruntum" rubber is coagulated in some parts by treating it with a

boiling effusion of Niama (*Bauhinia reticulata*), and *Landolphia* latex is sometimes coagulated by an effusion of a plant which is common over tropical Africa (*Costas lucanusianus*).

Landolphia latex is frequently coagulated by extracts coming from the Aurantiaceæ, and it is reported that *Manihot glaziovii* in German East Africa is coagulated by an acid extract of the fruit of *Adansonia digitata*. In Madagascar, Gambia, Peru, Guatemala, Nicaragua, similar methods of coagulation are used.

Phenol, Thymol, etc., have also been used as organic coagulants.

4.—By Beating and Maceration.

This is a method which is becoming more and more in vogue for the extraction of root rubbers on the Congo and elsewhere. The roots are dug up, cut into lengths, which are usually allowed to dry in the sun for some time. They are then soaked for several days in water, and the coagulated caoutchouc is beaten out with flails and collected. The rhizomes are treated in a somewhat similar fashion.

The extraction of Guayule rubber from the shrub known as *Parthenium argentatum* is carried out in some parts of Mexico on this principle.

5.—By Maceration and Extraction of the Caoutchouc by Solvents.

This is a method which is gradually finding favour for the preparation of rubber from plants which cannot be tapped, or in which the amount of rubber is small. It is coming into vogue for the extraction of Guayule rubber in Mexico and elsewhere (*see No.* 4). The shrub is dried, cut into pieces, and the caoutchouc is extracted from the finely divided tissue by means of a suitable solvent which is afterwards evaporated off and recovered.

To turn now to the raw rubber itself, prepared from the latex by coagulation. This is usually light in colour when first prepared, but it rapidly darkens when left exposed to the air, and becomes finally almost black in colour in the case of some rubbers. This change in colour has been shown to be due to the presence of oxidising-enzymes associated with the protein in the rubber, and can be prevented if suitable precautions are taken at time of coagulation to remove or destroy the active enzyme.

Rubber, if properly prepared, should be turned out in the form of compact masses, light in colour, and showing great tensile strength, and elasticity. Scientifically prepared rubber, such as that which is now being sent from rubber plantations in Ceylon and elsewhere, is washed and dried thoroughly after coagulation, and in this way the tendency to deterioration or decomposition is minimised. Block rubber is probably one of the best forms in which rubber can be turned out, and in this condition makes a striking contrast to the average West African rubber.

India-rubber is insoluble in water, but its bulk increases by absorption of this solvent, and it may take up as much as 25 per cent. of water in this way. It is insoluble in alcohol or acetone, the two most common solvents for the extraction of resinous products contained in it. It dissolves, if one may be allowed to use this expression in connection with the passage of a colloid from the solid to a double phase, in such substances as chloroform, toluol, benzol, ether, etc., etc., with greater or less rapidity, yielding viscous homogenous solutions. Raw caoutchouc is very elastic at ordinary temperatures, but if the temperature is reduced

to below zero it becomes hard and brittle, although it regains its former properties on warming. If heated to 75° C. or over it becomes gradually soft and sticky, and does not regain its normal properties on being cooled. If exposed to higher temperatures it melts and breaks down finally into simpler derivatives. If exposed for a long time to air and sunlight, rubber gradually gets less elastic and more sticky, and becomes finally oxidised completely into resinous products soluble in acetone. Hence it is that for practical purposes almost all the rubber of commerce undergoes vulcanisation. By vulcanisation, which is simply the chemical union of the caoutchouc with sulphur or sulphur chloride, a product is obtained which is more elastic than ordinary raw rubber, and which is at the same time less affected by atmospheric and temperature changes of any kind.

It must not be supposed, however, that commercial india-rubber is chemically pure caoutchouc. Even the best products are far from pure, and the poorer classes contain, in addition to the ordinary impurities, varying quantities of moisture, soluble impurities from the latex, and extraneous impurities such as sand bark, etc., which have found their way into the latex or have been intentionally added to it. Such rubber can, however, be purified further by mechanical washing which removes soluble and mechanical impurities in the rubber, followed by drying. This is, in short, the first process which all rubber goes through before manufacture, and the product thus handled is known as technically pure or washed rubber. The "loss on washing" is a valuable criterion from the manufactures standpoint, and is usually determined in practice. As the tables at the end of this article show, the "loss on washing" is a very variable factor.

The "technically pure" or washed dry rubber still contains certain substances other than caoutchouc. No amount of mechanical washing will remove these substances which are known as the resins and proteins of the rubber. They form the impurities always present in all rubber, and their determination is a matter of considerable importance, for the amount of these substances in a sample of rubber is liable to vary. One rubber may contain only 1-2 per cent. of resin, whereas others contain more than 60 per cent. of resinous products soluble in acetone. On the other hand, whereas Para rubber seldom contains more than 4 per cent. of protein, the rubber from *Manihot* or *Castilla* latex may contain at much as 10 per cent. of protein. Too little importance has been attached to these two impurities, which doubtless account for many of the observed phenomena in raw rubber, and in the handling of rubber in the laboratory or on the manufacturing scale.

As to the nature of the caoutchouc itself it must suffice to say that it is almost certainly a complex hydrocarbon (*i.e.*, a body containing the elements carbon and hydrogen in a definite proportion) belonging to a class of bodies hitherto unknown in organic chemistry—the cyclo-octadiens. To the extreme complexity of the caoutchouc molecule its unique physical properties are partly due.

In conclusion a table has been drawn up comprising all the important brands of india-rubber, their geographical and botanical origin, their analytical and technical constants as far as these are known. These tables have been taken largely from the data of Henriques and Soskin in the Gummi Kalendar for 1908, and have been revised from recent information appearing in *Der Tropenpflanzer*, *Die Gummi Zeitung*, *Le Caoutchouc et la Gutta-Percha*, *Journal d'Agriculture Tropicale*, and other works dealing with india-rubber.

TABLES OF RAW INDIA RUBBER BRANDS.

1.—SOUTH AND CENTRAL AMERICAN BRANDS.

TRADE NAME.	Geographical Origin.	Chief Export Centres.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
1.—Para, fine Island, soft cure.	Brazil, the islands of the lower Amazon and its delta, also other parts of the State of Para.	Para.	*Hevea Brasiliensis*, Muell. Arg.	17—20	1.9—2.1
2.—Para entrefine, Islands entrefine.			*Hevea Sp.* "*Itauba*" Ule. *Hevea Spruceana*, Muell. Arg.	18—25	Varies.
3.—Negroheads, or Islands coarse, Sernamby.			*Sapium Tabura*, Ule n. sp.	35—40	2—6
4.—Fine Para, upriver, hard cure.	The district lying on both sides of the Amazon and some distance up. Also the district drained by its large tributaries, the Jura Madeira, Rio Negro, etc., etc.	Manaos, Para, Iquitos Serpa.	*Hevea brasiliensis*, Muell. Arg.	15—20	1.9—2.9
5.—Upriver entrefine, hard entrefine.			*Hevea* "*Itauba*" Ule. *Hevea Discolor*, Muell. Arg.	18—25	Varies.
6.—Upriver coarse or Manaos Scrappy Negroheads.			*Hevea Sp.* from Rio Negro. *Hevea Similis*, Hemsl. *Hevea Biglandulosum*, Ule. *Micrandra Syphonoides*, Benth.	18—25	1.5—1.8
7.—Cameta Negroheads.	South-western Para.	River Harbour, Cameta.	*Hevea Brasiliensis*, Muell. Arg. *Hevea Spruceana*, Muell. Arg. *Sapium Tabura*, Ule n. sp.	37—42	1.2—2.2

C

1.—SOUTH AND CENTRAL AMERICAN BRANDS—(*continued*).

TRADE NAME.	Geographical Origin.	Chief Export Centres.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
			Hevea Brasiliensis and other Hevea species.	25—35	3.6—4
8.—Caucho Balls (also Peruvian). 9.—Caucho Slabs and Strips (also Peruvian).	Amazon district and its southern tributaries also yielding Para.	Manaos, Para, Iquitos, Serpa.	Various species of *Sapium* for Caucho blanco and *Castilla Ulei*. Warb. for Caucho-negro.	35—42	4—8
Ceará Scraps. Maniçoba.	Province Ceará, Piauhy and Riot Grande del Nore .	Ceará Parnahyba.	*Manihot Glaziovii*, Muell. Arg. *Man. Piauhyensis*, Ule. *Man. Heptaphylla*, Ule. *Man. Dichotoma*, Ule. *Man. Violacea*, Muell. Arg.	29	2.1
1.—Matto-Grosso, Fine and Entrefine.	Province of Matto-Grosso, Brazil.	Montevideo, Rio de Janeiro.	Spec. *Hevea*, probably *Brasiliensis*, and others.	—	—
2.—Matto-Grosso, Virgin Sheets, White Para.				15—30	2.5—3.5
3.—Matto-Grosso, Negroheads.				25—35	2.5—6
Matto-Grosso Sheets, Mangabeira or Pernambuco Rubber, Bahia - Mangabeira, Bahia Sheets.	The Provinces Permanbuco, Bahia, Goyaz, Sao Paulo, Maranhao, etc.	Santos, Rio Janeiro, Bahia, Pernambuco, Sergipe.	*Hancornia Speciosa*, Muell. Arg.	30	—

AMERICAN BRANDS.—(*continued*).

Trade Name.	Geographical Origin.	Chief Export Centres.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
Bolivian, fine, medium. Virgin, coarse, entrefine. Uncut Bolivian.	Bolivia.	Manaos, Mollendo, Arica, and various Peruvian and La Plata ports.	Various species of Hevea.	15	1, 6 (Much like Para).
Mollendo, fine, medium and coarse.	South Bolivia and small lots from Peru.	Mollendo.		15—25	1.9—3
1.—Peruvian, fine, medium and scrappy. Peruvian Balls (also Caucho).	Peru.	Iquitos, Manaos, Mollendo.	*Hevea Brasiliensis*, Muell Arg. *Hevea "Itauba."*	15—22	1.9—3
2.—Peruvian Tails (also Caucho).		Iquitos.	*Castilla Ulei.*, Warb.	20—35	3.6—4
Orinoco, also Angostura or Ciudad, Boliviar.	Venezuela.	Ciudad, Boliviar.	*Hevea Knuthiana*, Hub.	18—22	1.9—2.9
Ecuador scrap, sausage. Esmeralda sausage. Caucho blanco. Caucho Negro.	Ecuador.	Guayaquil, Esmeralda.	*Sapium Verum*, Hemsl. *Sap. Utile*, Preuss. *Sap. Decipiens*, Preuss. *Castilla Elastica*, Cerv.	23 (approx.)	5—7
Columbia Virgen or scraps (Caucho virgen). Carthagena.	Columbia.	Barranquilla, Tumaco, Carthagena, Savanilla.	*Sapium Tolimense*, Hort.	22—42	5—7·7

1.—SOUTH AND CENTRAL AMERICAN BRANDS.—(*continued*).

Trade Name.	Geographical Origin.	Chief Export Centre.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
West Indian, or Central scraps, slabs and sheets.	Costa Rica.	Port Limon, Puntas, Arenas, Greytown.		18—40	—
Nicaragua scraps and sheets, or West Indian or Central.	Nicaragua.	Bluefields, Corinto, San Juan del Sur, Greytown.		—	—
West Indian or Centrals.	Honduras.	Puerto Cortex, Belize.	*Castilla Elastica*, Cerv.	18—40	—
West Indian or Centrals.	Salvador.	St. Salvador.			
West Indian or Central, also Guatemala sheets.	Guatemala.	St. José, Livingston.		33	7·5
Mexican strips.	Mexico.	San Bemto, Vera Cruz.		35	8.3
Guayule.		Tampico and other places.	*Parthenium Argentatum*, A. Gray.	Varies considerably	Varies according to circumstances.
——	West Indies. Antilles Trinidad.	——	*Forsteronia Floribunda.* *Cryptostegia Grandiflora.* (Cultiv. : *Castilla Elastica* and *Hevea Brasiliensis.*)	—	—

2.—AFRICAN BRANDS.

TRADE NAME.	Geographical Origin.	Chief Export Centres.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
1.—Soudan Niggers.	French Senegal.	St. Louis.	*Landolphia Hendelotii*, D.C.	10—35	7
2.—Soudan Twists.	French Senegal.	Dakar.	*Landolphia Hendelotii*, D.C.	15—40	7
Gambia Niggers or Casamance.	British Gambia.	Casamance. Bathurst.	*Landolphia Hendelotii*, D.C.	20—40	5, 5
1.—Gambia Balls. 2.—Bissao Balls or Niggers. 3.—Bissao Flats.	Portuguese Guinea and the Bissao islands.	Bissao. Bulam. Caches.	*Landolphia Hendelotii*, D.C.	20—40	6
Massai Niggers. Konakry Niggers. Adeli Niggers.	French Guinea.	Konakry.	*Landolphia Hendelotii*, D.C.	—	3—6
Sierra Leone Niggers.	Sierra Leone.	Freetown. Konakry.	*Land. Owar.*, Pal. Beauv.	10—40	6—7
Sierra Leone Twists. Manoh Twists.	Sierra Leone.	Sierra Leone.	*Land. Hendelotii*, D.C.	20—30	6—7
Liberia Balls. Liberia Lumps.	Liberia.	Monrovia.	*Land. Owar.*, Pal. Beauv.	25—35	6

2.—AFRICAN BRANDS—(*continued*).

Trade Name.	Geographical Origin.	Chief Export Centre.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
Grand Bassam, Grand Bassam Niggers, Bassam Lumps, Assinee Twists.	Ivory Coast.	Bassam, Assinee, Accra, Lahou.	*Land. Owar.*, Pal. Beauv. *Ficus Vogelii*, Miq. *Funtumia Elastica*, Stapf. *Clitandra Elastica*. *Clit. Eugenifolia*. *Clit. Laurifolia* and *Carpodinus Hirsuta* for Accra Paste.	30	4.6
Gold Coast and Ivory Coast Lumps, Gold Coast and Ivory Coast Cakes, Ivory Coast Niggers.	Gold Coast.	Asim, Cape Coast Castle.		35—45	10—34
Lahou Twists, Lahou Niggers, Lahou Cakes.				—	
Accra Lumps, Accra Paste.				36—55	—
Adda, Quitta, Lome Niggers.	Togo.	Ports as named.	*Land. Owar.*, Pal. Beauv. *Ficus Vogelii*, Miq.	30	
Lagos Lumps, Biscuits, Strips, Silk Rubber.	Lagos.	Lagos.	*Land. Owar.*, Pal. Beauv. *Ficus Vogelii*, Miq. *Funtumia Elastica*, Stapf. (Lagos silk rubber from *Funtumia Elastica*, Stapf.).	—	4.5
Niger Niggers.	Southern Nigeria.	Old Calabar.		35	—
Benin Lumps, Old Calabar Lumps.				25—30	
Cameroon Balls, Biscuits, Twists, Bata Balls, Batanga Balls, South Cameroon Balls.	Cameroon.	Victoria, Kribi, Duala.	*Funtumia Elastica*, Stapf. *Land. Owar.*, Pal. Beauv.	25—35	11.4
Gabun Balls, Loango Balls, Mayumba Balls, Congo Balls.	French Congo.	Libreville, Brazzaville.	*Land. Klainei*, Pierre. *Carp. Landolphioides*, Stapf.	—	—

TRADE NAME.	Geographical Origin.	Chief Export Centre.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
Red Thimbles.	Portuguese Congo.	Kabinda.	As in French Congo.	—	—
1.—Upper Congo, black.	Independent Congo State.	Leopoldville, Boma, Banana.	*Land. Owar.*, Pal. Beauv. *Land. Klainei*, Pierre. *Land. Gentilii*, de Wild. *Land. Droogmansiana*, de Wild. *Clitandra Arnoldiana*, de Wild. *Clitandra Nzunde*, de Wild. *Funtumia Elastica*, Stapf. *Land. Thollonii*, Dew.	10	3.1
2.—Upper Congo Balls, Upper Congo Jakoma spindles, Ikelemba, Congo Djuma, Upper Congo Yengu.				7—10	3.3
3.—Black Kassai, fine.					
4.—Red Kassai, fine.					
5.—Kassai Loanda Sankuru, Kassai Loanda Nuts.					
6.—Upper Congo Equateur, 1.				8	—
7.—Upper Congo Katanga, Aruwimi, Aruwimi (form Equateur 1a), Lac Leopold.				5—35	3.2
8.—Uellé Strips.				6	5.0
9.—Upper Congo Ordinary (Balls and Cherries).				14	9.2
10.—Red Congo Thimbles.				25—35	—
Red Angola Thimbles.	Angola.	Benguella. St. Paulo de Loando. Mossamedes. Ambriz. Novo Redondo.	*Land. Owar.* *Land. Thollonii.* *Carpodinus Chylorrhiza*, K. Sch. *C. Gracilis.*	25—35	—
Loando Niggers, red, fine, and black fine.				10—20	3
Benguela Niggers.				30—50	5

2.—AFRICAN BRANDS—(*continued*).

Trade Name.	Geographical Origin.	Chief Export Centre.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
Lourenço Marquez, Inhambane, Beira, Ibo, Mozambique(balls,spindles,marbles).	Portuguese East Africa.	Ports as trade names.	*Land. Kirkii*, Dyer, and var. *Delagoensis*, Pierre.	10—20	3·6—8
Nyassa, Lindi balls, Donde marbles, Lamu balls, Mombassa, Tanga, "Mgoa" rubber.	German East Africa.	Chinde, Kilwa Lindi, Zanzibar. Tanga, Lamu.	*Land. Kirkii*, Dyer. *Land. Dondeensis*, Busse. *Clitandra, Kilimandjarica*, Warb. *Mascarenhasia Elast.*, K.Sch.	8.35	3·7—4.6
	British East Africa and Uganda.		*Land. Kirkii*, Dyer. *Funtumia Elastica*, Stapf.		
Clean brown spun Balls, White Virgin Sheets, White Slab. Pinky Madagascar.	Madagascar.	Tamatave, Majunga, Nossi - Bé, Fort Dauphin, Marandawa, Maintirano, Manandjary.	*Land. Madagascariensis*, K.Sch. *L. Pierrei*, Jum. *L. Sphaerocarpa*, Jum. *L. Tenuis*, Jum. *Mascarenhasia Lisanthiflora*, D.C. *M. Anceps*, Boiv. *M. Longifolia*, Jum. *M. Utilis*. Bak. *M. Geayi*. *M. Kidroa*.	20.30	7.1
Mixed Majunga, Black coated Slab.					
East Coast Niggers.			*Marsdenia Verrucosa*, Dew. *Cryptostegia Madagascariensis*, Boj. *Plectaneia Elastica*, Jum.	40	—
West Coast Niggers.			*Euphorbia Intisy*, Dr.d.Cast.	53	—

3.—EASTERN RUBBER BRANDS.

TRADE NAME.	Geographical Origin.	Chief Export Centre.	Botanical Origin.	Mean Loss on Washing. (per cent.)	Resin in Washed Dry Rubber. (per cent.)
Assam.	Assam.	Calcutta.	*Ficus Elastica*, Roxb. chiefly.	15—35	11.3
Rangoon.	Burma and Annam.	Rangoon.	*Ficus Elastica* and species of *Urceola*.	12—30	—
Penang.		Singapore.	Species of *Ficus*, *Willughbeia*, and *Urceola*.	20—40	5·5
Plantation Rubber, as fine, biscuits, sheets, fine crepe, worms, scraps, and Block Rubber. Rambong in various forms.	Malacca (Straits Settlements). Ceylon.	Penang, Colombo.	*Ficus Elastica*. (Rambong Rubber.) Cultiv.: *Hevea Brasiliensis*. *Manihot Glaziovii*. *Castilla Elastica*.	2—7 (Scraps, 10—15	2—4 2—6)
Sumatra.	Sumatra.	Singapore, Penang, Batavia, Padang.	*Ficus Elastica*, Roxb. *Willughbeia Firma*, *Urceola*, *Hymenolophus*, *Parameria*, *Chonemorpha*, *Ecdysanthera*.	35—50	7—15
Borneo.	Borneo.	Singapore. Bandjérmasin.	*Willughbeia Firma*, Spec. *Urceola*. *Parameria*.	—	
Java.	Java.	Batavia.	*Ficus Elastica*, Roxb. *Hevea Brasiliensis*.	—	—
	French Indo-China.	Haiphong, Saigon, Hanoi. Tonkin.	*Parameria Glandulifera*, Benth. *Ecdysanthera Micrantha*. *Xylinabaria Rheynaudi*. *Bleekrodea Tonkinensis*.		—

PRELIMINARY NOTE TO THE PAPERS AND DISCUSSIONS.

In preparing and arranging the papers read and discussed at the 1911 Conference it has been decided to abandon the idea of taking them in chronological order. Some were necessarily read out of their natural connection and one or two were read after the Conference week had come to an end.

It has therefore been decided to present them so grouped that papers dealing with the same order of subjects come together. The Conference only lasted a week, and this places the date of reading of any paper within a few days at least, so it is not probable that any questions of priority will be complicated by this method of arrangement.

CHAPTER II.—Section I.

The Rubber-Planting Problem as it Presents Itself in Different Countries.

(I.) R. Fyffe.—"Rubber in Uganda: Retrospective and Prospective."

(II.) The Colonial Government of Madagascar.—"The Production of Rubber in Madagascar."

(III.) F. A. Stockdale.—"Lecture on the West Indies."

(IV.) M. C. Hugot.—"The West African Varieties of Latex and Raw Rubber."

(V.) André Cremazy.—"Rubber Plantations in Fernch Cochin China."

(VI.) J. Huber.—"Rubber Trees and Wild Rubber Reserves of the Amazon."

(VII.) Emilio Castre.—"The Rubber Industry in Peru."

(VIII.) Aug. Chevalier.—"The Rubber Problem in French Western Africa."

(IX.) Kelway Bamber.—"Notes on the Planting and Production of Rubber in Ceylon."

The CHAIRMAN said: This, the first regular Conference Session, must necessarily be a rather confused one. A great many of the papers that have been promised are not in yet; a number of them that have been sent in have not yet been received from the printers, and finally, the whole of the Conference Committee has hardly been able to get together until to-day. More or less confusion is, then, inevitable, but I hope it will be only temporary. This afternoon we have two papers ready for reading. The intention is that all these papers and discussions shall be printed subsequently and incorporated in a book, as they were in 1908. That being the case, it is desirable that the discussions, as well as the papers, be ready to put into print as soon as possible so that we can get the Conference book out promptly. It will, therefore, be well if everyone who takes part in the discussion will hand in to me at the close of the Conference, or as soon after as is possible, a written abstract of his remarks in the form in which he would like this to appear in the Conference Book.

The first paper to which we are to have the pleasure of listening this afternoon is on the subject of "Rubber in Uganda: Retrospective and Prospective," and it is to be read by Mr. R. Fyffe, of the Botanical and Forestry Department at Entebbe, Uganda.

RUBBER IN UGANDA.

Retrospective and Prospective.

By Mr. R. FYFFE,

First Assistant Botanical, Forestry and Scientific Department, Entebbe, Uganda Protectorate.

The first year in which rubber figured as an article of export from Uganda was 1902. During that year 68,000 lbs. were exported. For the six following years there was a decrease in the quantity exported to 45,000 lbs. per year, although the amount is not stated in the export returns, undoubtedly a good deal of the rubber exported has been rubber in transit from the Congo.

In the year 1909 the export increased to 105,000 lbs. The source of the rubber collected in Uganda, with the exception of a quantity exported in 1909, is the *Landolphia* and *Clitandra* vines, the increase in 1909 being due to the working of *Funtumia elastica.*

The species indigenous to Uganda are: *Clitandra Orientalis,* K. Schum. *Landolphia Dawei* Stapf, and *Funtumia elastica* Stapf. The discovery of *Funtumia elastica* in Uganda, was made by Mr. M. T. Dawe, F.L.S., the Superintendent of Forests, in 1906, in the Mabira Forest, which is situated in the County of Kyagwe, near the Victoria Nyanza Lake. Previous to its discovery in Kyagwe, *Funtumia Elastica* had not been known to occur so far East. Its discovery in the Mabira forest led to an examination of the large forests in Yenyoro close to the Albert Lake, with the result that it was found there also. *Funtumia Elastica* is found in the large forests only, and it is interesting to note that whereever it occurs, *Funtumia Latifolia* Stapf, which is not a rubber-yielding species, is usually abundant also. This species is widely distributed throughout the country.

A study of the composition of the forests of Uganda shows that there are at least three distinct types, and in only one of these is *Funtumia Elastica* found. The predominant species of timber trees with which *Funtumia Elastica* associates are, species of *Entandrophragma, Khaya, Chrysophyllum, Maba, Celtis, Croton,* and *Alstonia.* These species, together with *Cynometra,* constitute the bulk of the timber in the larger and drier forests. *Cynometra* usually grows in clumps, and it is interesting to note that *Funtumia Elastica* never occurs where this species predominates. A forest of the above constitution contains very few rubber vines.

The dominant species constituting the bulk of the timber found in the second type of forest are *Piptadenia*, *Pyenanthus*, *Parkia*, *Canarium*, *Raphia*, *Phœnix* (Palms), and *Symphonia*. These species generally represent a swampy forest, and while *Clitandra* and *Landolphia* vines are usually abundant, *Funtumia Elastica* is non-existent in a forest of this character, the fact that this type of forest is swampy may account for the absence of this species.

The species which constitutes the bulk of timber in the third type, and which gives it such a distinctive appearance is *Podocarpus Milanjianus, var. Arborescens*; associating with this tree is found *Baikaea Eminii*. This class of forest is very swampy, and rubber-producing species are not found in it.

The collection of vine rubber is done by natives, and many of the vines have been injured by the methods employed in tapping. The vines often reach a great height by climbing over the branches of the tall forest trees; they are often many feet in length. The tapping of vines is very arduous, and not a little dangerous; to see the boys clinging to a vine, and swinging many feet in the air busily engaged in the collection of latex, makes one marvel at the courage they must possess; some of them are almost as good at climbing as are the climbing inhabitants of the forests.

In tapping the vines oblique cuts are made a few inches apart, on every accessible portion of the vine. The latex is collected in a piece of banana leaf, and at the end of the day is poured into an earthenware pot, where coagulation is effected by boiling, the resultant clot of wet rubber is afterwards rolled into biscuit form, and hung, or laid on a table, in the tapper's hut to dry. Owing to the method employed by the native in its preparation this rubber contains a good deal of mechanical impurities, and the rubber is rather inferior, but when properly prepared it is of excellent quality; fortunately, the native begins to see the benefit which is to be derived from the sale of good rubber, and he now turns out a more marketable product, by using more care and cleanliness in its preparation. In view of the nature of the vines it is doubtful if they could be tapped on less destructive methods than those practised by the natives, and the amount of vine rubber exported will, I believe, continue to decrease, and eventually cease to be an article of export from Uganda. The cultivation of this class of rubber plant is not to be recommended; it is a very slow grower; it does not yield large quantities of latex, and its habit makes it unamenable to cultivation.

Following the discovery of *Funtumia Elastica*, steps were taken to preserve the trees; and the forests containing it, which are fortunately large, are being leased only to responsible companies, who have to observe regulations brought out by the Government for the purpose of conservation. The Mabira Forest Company, who are working the Mabira Forest have exported large quantities of rubber of excellent quality during the past few years.

At present, the most approved method of tapping is the "herring-bone" system. Unlike the Para rubber tree, *Funtumia Elastica* has no wound response, and gives the best results, from three to four tappings in a year. The initial cuts are made about 18 in. apart, from the base upwards, and on re-tapping a new cut is made about 1 in. above the last one, paring the lower edge of the cut as is done with Para being unproductive.

The trees may be tapped from the base to a height of 20 to 30 ft. at one tapping; this is a heavy drain on the tree, and it should be

allowed a few months rest before it is again tapped. It is not advisable to tap beyond 30 ft. at one tapping. This height may be exceeded without doing any injury to the tree, if, at the first tapping the lower part of the tree is tapped, going higher at the second tapping, and descending to the lower part at the third tapping, covering a well-rested area at each tapping.

Trees which are heavily tapped invariably lose their leaves, and many of the twigs die ; this is undoubtedly a sign that the tree is unable to support itself owing to the heavy drain upon its resources occasioned by tapping.

Wounds made on a *Funtumia* tree do not heal up so quickly as do wounds inflicted on the Para and Ceara rubber trees by tapping ; this may be accounted for by the scanty crown of foliage which the former possesses when compared with the latter two species, thus it is unable to assimilate, and elaborate plant food rapidly.

Various tapping implements have been tried in Uganda. One of the best is the Christy knife. This is a modification of the " V " knife ; it makes a very clean cut. Another, which finds favour with the tappers, is a modification of the farrier's knife ; it makes a clean cut, works easily, and is not liable to choke.

In tapping, it is advisable to use a pricker, as the necessity to make a deep cut is thereby minimised, and I consider it of great importance to reduce the excision of bark to a minimum, by cutting only, a very deep channel has to be made if the maximum yield is to be obtained ; if a pricker is used it is not necessary to cut so deeply, the shock to the tree is not so great, and the wounds not being deep heal up much quicker, and this must have an important effect on the yield obtained from repeated tapping.

On a whole, the yields obtained are very disappointing ; experiments have proved the yield of mature trees to be about 5 to 6 ozs. of dry rubber per year, tapped to a height of 30 ft.

The amount of caoutchouc in *Funtumia* latex is about 33 per cent. *Funtumia* latex coagulates readily by boiling, but the method generally adopted is coagulation by chemicals and hot water in long wooden troughs. Large quantities of latex can readily be dealt with in this manner, and the troughs produce a coagulum which conveniently passes through the crêping machine.

Funtumia Elastica is an exceedingly slow grower, and I doubt if it is of any importance to Uganda from a plantation point of view. The growth of plants in the forest is very slow, and although they make much more progress in the open, their rate of development is disappointing.

The average girth of 4-year old trees, growing in the open at Entebbe is 10 in., these trees have stems averaging 5 ft. in length, their height averages about 14 ft. and they carry heavy crowns of foliage.

Before the discovery of *Funtumia Elastica* in Uganda a number of plants were introduced through the Royal Botanic Gardens, Kew, from West Africa, in 1903. The average girth of these trees is 21 in. Several of the largest were tapped when 7 years old, and the results were in every case disappointing. The largest tree yielded in an experiment which extended over one year, 1½ ozs. of dry rubber. The tree was tapped by paring and pricking once every three months to a height of 6 ft.

From the foregoing it will be seen that although mature forest trees yield rubber in payable quantity, this is not a plant to be recommended for cultivation, more especially when its rate of growth and

yield are compared with that of Para and Ceara rubber trees. It is almost certain that the amount of indigenous rubber exported will gradually decrease, due to the destruction of the vines, and the exhaustion of many of the trees, and probably an important factor will be the price of rubber in future; this may make the collection of indigenous rubber unprofitable.

With exotic rubbers of proved plantation value in other countries the prospect is encouraging, and it is hoped that before the exports of indigenous rubber materially decrease, that large areas of these will be in bearing. The growth and yield of some are at an early stage extremely gratifying.

The geographical position of Uganda is from the equator northwards, and the elevation of the Lake Victoria district is 3,863 ft. At present most of the planting is being done in this district, in the County of Kyagwe. The average rainfall in this area is 60 in., well distributed throughout the year. The average temperature is 73° Fah. There is no well-defined dry season. December, January and February are recognised as the driest months; but even then a good deal of rain may fall. Hurricanes and storms liable to cause great damage are very rare and local. Occasionally a hail-storm has a devastating effect on vegetation, the leaves will be perforated and torn from the trees and the bark of young plants is sometimes badly damaged, but as stated these storms are very rare indeed.

Planting on a considerable scale was commenced three years ago and the area at present under rubber is about 3,200 acres. Of this approximately 2,200 are under Para, 900 are under Ceara, and 100 are planted with *Funtumia* and *Castilloa*.

In Uganda the best land is covered by a tall, dense growing reed, known locally as elephant grass (*Pennisetum purpureum*), this grass generally grows on deep rich soil which is fairly retentive of moisture; it grows very strongly, often reaching 15–20 ft. in height, and by forming a dense covering effectually prevents pernicious weeds from getting a hold. Elephant grass is comparatively speaking a surface rooting plant, and land covered by it is not difficult to clean. Land can be purchased freehold for about Rs. 2 (2s. 8d.) per acre; clearing operations cost from Rs. 10 (13s. 4d.) to Rs. 15 (£1) per acre. The total cost of bringing an acre of rubber to the producing stage (5 years) is estimated at from Rs. 75 (£5) to Rs. 150 (£10).

An estate could be worked so that coffee would form an article of export before the rubber reached a tapable size. Coffee bears in Uganda at from 2–2½ years, if planted on suitable land. Labour is locally abundant, and as transport facilities are improved it will be more plentiful. At present much labour is absorbed in transport. The pay of the labourer is from Rs. 3.50–Rs. 4 per month, he finding his own food and dwelling house. The Baganda are an easily taught people and there will be no difficulty in teaching them to become first-class plantation labourers and tappers.

Ceara rubber (*Manihot Glaziovii* Muell. Arg.) was introduced through the Royal Botanic Gardens, Kew, 10 years ago. This species grows and propagates itself very rapidly. Many trees attain a girth of over 20 in. at three years of age. The girth of a few 10 year old trees growing on very poor stony soil is 30 in. The largest tree I have seen was 8 years old, and measured just under 4 ft. in girth. The Ceara rubber tree will grow on stony and otherwise poor soil, but it readily responds to good cultivation, and it is easily injured or its growth retarded if at all neglected.

Although Ceara rubber has been grown in the country for 10 years it is only within the last year that it has been recognised as a valuable rubber-yielding tree; experimental tapping in the Botanical Gardens, Entebbe, showed such little promise, that it was at one time considered of no plantation value, and at many of the mission stations, where it had been planted soon after its introduction, it was abandoned owing to the disappointing results obtained. The method of tapping adopted was that of pricking after removing the dry outer bark, and smearing the tree with a coagulant. This is the method generally adopted in tapping Ceara rubber trees. During the past year the "half herring-bone" system was experimented with in the Botanical Gardens, and on a large estate in Entebbe. The results obtained are highly gratifying, and I believe that this system is worthy of extended trial.

From 20 trees of an average girth of 19 in., and three years old, a yield of 37 ozs. of dry rubber was obtained. The trees were tapped on the "half herring-bone" system (paring and pricking) to a height of 3½ ft., every alternate evening for a month. These trees, together with many others, have been tapped on this system, more or less regularly for a period of 13 months, and with the exception of a few which have been *too deeply cut*, they in no way appear to suffer from the effects of tapping. In another experiment three trees of an average girth of 30 in., and between 7–10 years old, were tapped to 3½ ft. every day for a fortnight. The yield obtained is 33 ozs. of dry rubber, equal to 12 drs. of dry rubber per tree per day. This experiment was stopped after a fortnight, as the trees showed signs of *exhaustion*.

The advantages of this system over that of pricking only, are obvious, provided that tapping is done carefully, and that the *smallest amount* of bark is removed, depending principally on the *pricker* reaching the latex vessels, and if the tree will stand the repeated removal of its bark without injury. The yields obtained are superior to those obtained by pricking only; the greatest advantage being that the latex is collected in liquid form and can then be transformed into rubber of any desired shape at the factory. It allows of the coagulation by chemical or other means, and the removal of all mechanical impurities.

As stated previously, this method has only been experimented with for *a year*, and it is well not to be over sanguine of the ultimate results; but so far good results, on a whole, have been obtained. The trees are (unless those which have been tapped too deeply) renewing their bark very rapidly.

The yield obtained from Ceara trees varies remarkably in individual trees, and this points to the necessity of seed selection when making new plantations. This tree particularly lends itself to speedy results from seed selection, owing to the comparatively early age at which its latex yielding capacity can be tested.

Although Ceara rubber has been dealt with in this paper before Para rubber, it is owing to its having been first introduced and not to the latter being considered in any way of less importance; in fact, it will be noted from the areas in cultivation, that it is in Para that planters have so far placed their confidence. Para rubber was first introduced into Uganda in 1901. During that year one plant was received from the Royal Botanic Gardens, Kew. As the Uganda Railway was not completed then, this plant was many months in transit, and it arrived at the Botanic Gardens, Entebbe, in very poor condition. It was planted on the lake shore at Entebbe, a few feet above the lake level, and it soon commenced to make good growth. In 1904 the tree was 21 ft.

in height and of correspondingly good girth; when six years old it was 18 in. in girth, and at nine years it attained a girth of 35 in. In 1904 seeds were introduced from Ceylon, and trees raised from these have reached a tapable size at four years from the time of planting.

These results have been obtained in the Botanic Gardens, Entebbe, but in other parts of the country this tree grows wonderfully well. The trees begin to bear seeds when about five years old.

The tree previously mentioned as being the first Para rubber tree introduced, was tapped when seven years old. It yielded in 107 tappings 16½ ozs. of dry rubber. The tree was tapped every alternate day, thus the experiment extended a little over seven months. The system was the "full spiral" once round the tree to a height of 6 ft. I feel sure that if the "herring-bone" system had been practised, this tree would have given better results.

In another experiment a five year old tree, tapped on the "half-herring-bone" system, to a height of 6 ft., yielded in 107 tappings 15½ ozs. of dry rubber.

Another experiment with tapping 118 trees of an average girth of 20½ in., extended over a period of four months. The total weight of dry rubber obtained is just over 50 lbs., which is equal to a yield of just under 7 ozs. per tree for the period. This experiment commenced on September 1st, 1910, and the trees were tapped to the end of May, 1911, to my knowledge, and there was no decrease in the yields obtained then, from those during the early months of the experiment. It was my intention to tap the trees every alternate day for a year, if wound response continued good, to ascertain what the actual return from a young plantation would be. Basing an estimate on the above experiments, I feel confident that the yield will average about 1 lb. of dry rubber per tree.

In Uganda, I consider that there is a great future for Para and Ceara rubber. Para, I would recommend as a permanent crop, while for a quick return I would prefer Ceara. Para is the strongest tree, and it would withstand the effects of oft-repeated tapping better than would Ceara.

Castilloa Elastica Ard was introduced in 1901. The tree makes very rapid growth and it shows promise up to the fourth and fifth year, when it is attacked by a native boring Longicorn beetle (*Inesida Leprosa* Fabr.), the beetle usually attacks the trees where the branches fall off. Here a deep scar is made and renders attack particularly easy. This beetle is widely distributed throughout Uganda, its native host being *Chlorophora Excelsa*, a tree closely allied to *Castilloa*. Owing to its liability to attack it is extremely improbable that any success will attend the cultivation of this species in Uganda. It is interesting to note that this beetle is common in West Africa also, and is there destructive to this species of rubber.

During 1908 seeds of *Manihot Piauhyensis* Ule, and *M. Dichotoma* Ule, were received from the Royal Botanic Gardens, Kew. So far, none of these have made growth equal to that of Ceara, and it is too early to express an opinion on the merits or demerits of either from an economic point of view.

From the foregoing it will be concluded that the exotic rubbers of most value to Uganda are Ceara and Para. From my observations I think the conditions are entirely suited for the rapid development of both species. Considering the elevation, and what may appear to be a scanty rainfall, one might be inclined to the belief that such a product

as rubber (especially Para) would not flourish in the conditions which obtain in Uganda. It is thought that the position of Uganda on the equator largely compensates for altitude, and undoubtedly the rich, deep virgin soil, which is fairly retentive, together with the fact that the rainfall is well distributed throughout the year, have an important effect on the economic development of plants.

The Chairman having invited discussion,

Mr. HERBERT WRIGHT: I have listened with pleasure to the paper which has been read with reference to Rubber in Uganda, and while we who are operating mainly in the Middle East cannot help looking to Africa as a rather disappointing continent for future supplies, we are glad that efforts are being made to maintain a supply of some importance in the centre of Africa. The species which is apparently being cultivated there is *Funtumia Elastica*. I noticed that the lecturer gives a yield of 5 to 6 ozs. per tree per annum. That, of course, can never compare with the yield from even 5 to 6 year old trees in the Middle East, and can certainly never make a favourable impression when it is compared with the yield from trees, say, 10 years old in Malaysia which are giving us from 4 lbs. to 8 lbs. per tree. However, it is a source of rubber, and on that account we cannot afford to neglect it. I see in this room a gentleman who has traversed the greater part of New Guinea, Samoa, Central Africa, and even Central and South America, and who has had a considerable experience with *Funtumia*. I should be glad if Dr. Preuss can give us his views of probable yields in various parts of the world.

Dr. PAUL PREUSS: *Funtumia* in a cultivated state has been very little known until recently. The oldest cultivated *Funtumia* tree is about 12 years old. *Funtumia* was discovered in 1898, and of course you cannot speak with certainty as to cultivation if you plant only a few trees. To get a proper view as to the yield of a rubber tree it is not sufficient to plant 20 or 30 or 50 trees; you have to cultivate it on a larger scale, and you have to take an average of several hundred trees cultivated under the same conditions. Until now we have had only the Cameroon Plantations, in which one has been able to tap the *Funtumia* on a larger scale—*i.e.*, over several hectares—and there they have found out that the yield of trees about 8 to 9 years old is not more than 40 grammes per tree as an average. The yield of single trees has, of course, been sometimes found to be much larger, but that does not alter the case, for it always has been found that if you tap a single tree with great frequency you get a very high yield, but if you afterwards plant and cultivate the tree on a large scale you will be disappointed. The same experience has been met with in New Guinea. Our trees there are much younger than they are in the Cameroons, but the yield from trees 4 to 5 years old are nothing like the yield you would get from *Hevea* of 5 years. *Funtumia* is not worth tapping when from 4 to 5 years old, for the bark is very hard and the latex falls very slowly, the yield being very small, compared with that of *Hevea*. *Hevea* is from every point of view, better for cultivation. Mr. Fyffe says that *Funtumia* is an exceedingly slow grower. I have had a very different experience in New Guinea and in the Cameroons. Wherever I saw a *Funtumia* tree, say, 4 years old, it was the size of a man's leg, and the tree at least 4 metres (12 to 13 ft.) high. You can occasionally see *Funtumia* 3 years old and 5 metres high.

Mr. FYFFE: A tree growing in the gardens at Entebbe has only a girth of 10 inches, and that was growing under favourable conditions.

Dr. PREUSS: It seems to grow much more slowly in Uganda than in the Cameroons and New Guinea.

Mr. FYFFE: The yields I mentioned were from mature trees in the forest—5 to 6 ozs. per tree, and not from cultivated trees. We only got a few ounces from cultivated trees 8 years old.

Dr. PREUSS: The first tree I tapped in the Cameroons—I remember, it was a tree of about 16 inches circumference—yielded me a full bottle of latex on the first tapping. That was a very large amount compared with what we get from the cultivated trees. When I first got such a good yield I thought the tree would be very good for cultivation, but the experience I have had up to now is rather disappointing.

Dr. SCHIDROWITZ: There are one or two points in the paper to which I should like to refer. I think that the general principles of *Funtumia* cultivation have been sufficiently exhaustively treated, but as I have had a considerable experience with *Funtumia* rubber as a finished product there are one or two points on which I should be glad of a little information. On page 5 I presume there is a misprint. The lecturer says "The amount of caoutchouc in *Funtumia* latex is about 0·33 per cent." I presume that means 33 per cent.

Mr. FYFFE: Yes.

Dr. SCHIDROWITZ: *Funtumia* latex, is exceptionally rich; generally speaking, richer than *Hevea.* I have found 45 per cent. of dry rubber in it, which is very high. When properly prepared, it is an excellent rubber, but as a plantation species it has many disadvantages compared with *Hevea.* There is not the slightest doubt that planters in Africa (at any rate in Uganda) are now devoting themselves to *Hevea* rather than to *Funtumia.* There are a number of other trees in Uganda of very considerable interest; for instance, *Funtumia Latifolia,* to which Mr. Fyffe referred. The latex of this is extremely resinous, but there is a certain amount of rubber in it. Another question I should like to ask is whether *Funtumia Latifolia* is the same as *Funtumia Africana.*

Mr. FYFFE: No, they are distinct species.

Dr. SCHIDROWITZ: I have been informed that *Funtumia Africana* is only *Funtumia Latifolia* growing on the edge of the forest.

Mr. FYFFE: No; it is quite distinct.

Dr. SCHIDROWITZ: Is there not some resemblance?

Mr. FYFFE: There is some resemblance, but the leaves are distinct.

Dr. SCHIDROWITZ: I have been led to think that the natives mix the two, and I wished to find out to what degree, that was from ignorance.

Mr. FYFFE: They all know the difference, because they are taught to press it with their fingers; it rapidly coagulates if you get a little between your finger and thumb.

Dr. SCHIDROWITZ: Then I see you mention *Chrysophyllum*; I should like you to give us a little information about that—what is its yield and what is its botanical nature.

Mr. FYFFE: Some latex has been collected from these trees and sent home after being treated, but it has been reported as being of no value whatever. The samples were prepared by the botanical department, but we are told they are not worth exhibiting.

The CHAIRMAN: Mr. Fyffe said something about tapping. I shall be glad if he can give us some further information about this, and tell us whether any special experiments have been made.

Mr. FYFFE: Many have been made, but they have found the herring-bone system the best. I believe they have dispensed with the pricker. They say the pricker is a good thing, provided you do not prick too deeply.

The CHAIRMAN: Has it been found that the pricker produced any excresence.

Mr. FYFFE: We have not noticed that. If the native does not use a pricker he is apt to cut too deeply, and some of the trees have suffered.

A MEMBER: Do you refer to trees in the open or in the forests? May it not be the case that the slow rate of renewal is caused by the fact that the tree is surrounded by other trees?

Mr. FYFFE: Quite possible. *Funtumia* has always a scanty kind of foliage.

Dr. SCHIDROWITZ: In some districts it grows very well in the open, does it not?

Mr. FYFFE: Ten inches in four years is not very much.

Dr. STEVENS: There are one or two other points; if the tree grows in the open it has a big crown, has it not?

Mr. FYFFE: Yes.

Dr. STEVENS: You say the trees invariably lose their leaves after tapping. Do you mean that the tapping brings on wintering?

Mr. FYFFE: Severe tapping does: I am sure of that. By excessive tapping I mean cutting over the same area up to 30 or 40 ft. If you tap moderately you will not have any evil effects.

Dr. STEVENS: From experiments I have made in the East we get in *Hevea* latex well over 40 per cent. of rubber. I think on an average of 100 or more trees I have got it up to 42 per cent., and in individual trees to more. Rambong, again I have got to over 40 per cent. A great deal depends on how the trees are tapped.

The CHAIRMAN: Mr. Fyffe says they have been trying the herring-bone system with *Ceara*; perhaps it would be desirable if he would tell us a few facts about it.

Mr. FYFFE: When I went out to Uganda some three years ago everyone was running down the *Ceara*. I went out to do my best for everyone, and I thought I would take it up. I tried various systems of tapping, such as pricking, the "V" cut, and one or two other methods, but found they were not very satisfactory. I tried the herringbone, and from that I got very good results. I estimated from some experiments that I should get well over 1 lb. from trees of 3 to 4 years, and one tree between 7 and 10 years old—we do not know the exact date—yielded 19 ozs. of rubber in 2½ months. That experiment stopped because I had to leave off tapping and go on tour. The trees did not appear to have suffered, and if anyone wishes to see the new bark I should like to see them down at the stand because I have one there to show. This system does not seem detrimental to the tree if carefully done. In tapping I generally use a very fine pricker. I take a small peeling off and get the latex out by the pricker. I should like to hear what experience other people have had. We are only adopting the half herringbone.

Mr. T. Petch: What is the rainfall? We found in Ceylon that if you tap too much with a rainfall of from 40 to 50, the whole of the bark dies.

Mr. Fyffe: So far in Uganda none have died, and few trees have suffered from deep tapping, but we have not had much tapping.

Dr. Esch: What is the best medium for coagulating?

Mr. Fyffe: I have tried acetic acid, but the best rubber has been produced by coagulating in water only.

Dr. Stevens: Does it cream up to the surface?

Mr. Fyffe: Oh, yes.

Prof. Warburg (Berlin): We can tap *Ceara* in the northern part only by pricker, but in the southern part we can tap by the herringbone. On the west coast also we can do it. Apparently it is only the rainfall that makes the difference. I am glad to agree with Dr. Preuss as regards *Funtumia*, though we had better results last autumn. We have gone to 60 or 70 grammes per tree. It is not the same with *Hevea*, where we tap every day, because we have tapped the *Funtumia* only once, and we do not know how often we can do it in the year. We hope in the case of older trees to tap four times, but it is not yet certain that we can. Then, again, we have quite unskilled labourers, not as in the East, where the labourers are used to tapping. We think that bye-and-bye we shall get much better results from *Funtumia*, but of course they will never come near to the results of *Hevea*; therefore people will not think of planting rubber in large quantities. All the plantations go for *Hevea* planting, but it is possible we shall have good success also from *Funtumia*, chiefly because it is easy for the worker. We can plant any amount of *Funtumia*—much more than *Hevea*—and so we think that bye-and-bye we shall get good results from it, but at present it is impossible to say.

Mr. T. Powell (Chief of the Economic Plant Division Department of Agriculture, East Africa Protectorate): One of the previous speakers referred to Africa as being a source of rubber supply, but said it was not likely to be equal to the Far East, but I can assure that gentleman that so far as East Africa is concerned we mean to be very keen competitors of the Far East, and it is with *Ceara* we mean to do it. None of our plantations are more than about three years old, but the secret of the whole thing is that we can commence to tap the *Ceara* tree at 18 months. We had rubber from an 18 months old tree valued at 3s. 6d. per lb. long before the rubber boom commenced. On one of our estates the trees are not three years old yet. All these trees average 3 ozs. of dry rubber per tree per annum. I have been down to German East Africa on two occasions and seen trees which are yielding 3 lbs. to 4 lbs. of dry rubber per annum, and one tree is said to have produced 20 lbs. of dry rubber.

Mr. Herbert Wright: For how many years?

Mr. Powell: It has been going on for 12 years. We do not know how long we can go on tapping. I had trees myself on some of the Government's experimental farms which I have tapped at 18 months or two years; they are giving us about 2 ozs. per tree per annum. I have got all our rubber from three-year-old trees. I think we have a very valuable thing in *Ceara*.

The Chairman: We have had a very interesting discussion and as this subject will come up again I think we can now pass on to the next paper, which will be by Mr. Harold Hamel Smith, editor of *Tropical Life*, and is on "The Need of Organisation in the Supply of Literature and Labour for Rubber and other Planters."

At the opening of the Conference on Wednesday the discussion of Mr. Fyffe's paper was continued, with Dr. Torrey in the chair.

The CHAIRMAN : On Monday, when Mr. Fyffe's paper on Rubber in Uganda was read, the discussion was interrupted much sooner than was intended, and therefore we are devoting some time to it this morning.

Mr. FYFFE : I have been asked by several gentlemen that there should be a further discussion on my paper, and I shall be pleased to answer any question which may be put to me.

Mr. Fyffe then read the latter part of his paper as already given.

Dr. E. BLACK : Two very important points arise from Mr. Fyffe's paper. The first was discussed on Monday—namely, the distance at which trees could be planted. The second, which is less understood and about which far less is known, concerns the planting of the various species of trees which produce *Manicoba* rubber. The only one of this species to which he has alluded is the *Ceara* tree. My excuse for addressing you is that I have during the last five years visited most of the large rubber countries and have just returned from Brazil, so that I have seen more of the different rubber-producing species than falls to the lot of the average wanderer, and some of my experiences and observations may be of interest.

As to the distance apart at which trees should be planted, two views were taken yesterday, both rather extreme. Mr. Wickham contended they should be 40 to the acre, and Mr. Wycherly that they might be 240. The question can be fairly simply disposed of. The man who planted any other kind of tree as close together as rubber trees have been planted would be classified very quickly as a lunatic. The experience of the world since the days of Noah with regard to fruit-bearing trees is that they must be planted a definite distance apart—and that distance is based on the distance their roots travel. It is the experience of agriculturists the world over in regard to trees producing marketable substances that you must plant them far enough away to prevent the roots interlocking. The reason why fallacious statistics have been brought forward to try and prove the opposite as regards rubber is that it takes longer for the rubber tree to mature, and our experience has not been sufficiently long to come to the same accurate conclusion as with fruit trees: therefore it is perfectly obvious that those who contend that rubber trees should be planted close together are setting at defiance the experience of growers of every other kind of tree all the world over. With regard to their figures, I would remind you of the old joking comparison of the positive, comparative and superlative degree of lies. The first degree is lies, the second is d—— lies, and the third statistics. Statistics have never been more misused than in relation to this question of the planting of rubber. The idea seems to be "Post hoc ergo propter hoc"—that because a man plants rubber trees close together and thinks the result is good for a few years therefore it would always be the same. Unfortunately they are going to suffer in the years to come.

The second I mentioned is going to be of extreme importance to those who are planting that group of trees, several varieties of which produce *Manicoba* rubber. These fall into three classes : the *Ceara* variety in the north of Brazil, the San Francisco and Pianky varieties of the interior, and the Jequie variety of the south of the State of Bahia. They are totally separate and distinct. Planters have planted the *Ceara* tree

because it was the best known, but they have been totally regardless of whether the conditions of climate and rainfall are suitable for it. I am sorry I have not brought with me the immense collection of photographs of these trees planted in Brazil which I have taken under different conditions of soil, climate and rainfall, but they establish this fact that if you take one of these *Manicoba* producing trees from its own soil and put it in a different soil you do not get rubber. I have photographed the trees grown in Brazil, the dimensions of which far exceed anything Mr. Fyffe has mentioned.

Mr. FYFFE: Possibly older trees.

Dr. BLACK: Not at all; 8 years old—younger than most—and much larger than anything you mentioned, the yield of which was 20 grammes of dry rubber—absolutely disastrous. I have proved over and over again that if you take a tree from the climate where it is produced under the influence of summer heat and summer rains and put it in a district where there is great heat and drought, or winter cold and rain, you cannot get a yield.

Dr. CHRISTIE: I am happy to be one of the "lunatics" who advocate close planting, but not close planting in connection with *Hevea*. The subject of Mr Fyffe's paper I take to be *Funtumia*, and *Funtumia* the last speaker would know, if he has travelled much, cannot be grown unless it is planted very closely, for the simple reason that you cannot get a tapping stem sufficiently tall or clean to tap otherwise. The tree has the peculiarity of pruning itself, and it cannot bring that self-pruning characteristic into action unless you do plant closely. You must thin out afterwards. I am sorry I was not here when Mr. Fyffe read his paper; but there are certain points I should like to emphasise. Uganda has suffered for some time from a plethora of knowledge of the habits of trees in the forest, with no knowledge of the possibilities of plantation trees. In West Africa you can see many thousands of acres planted with *Funtumia* without any knowledge as to the growth of the trees in the forest, and if you study the growth of the trees in the forest you will see that they must have been planted closely. The tree is entirely different in its habits from *Hevea*. It is a deep-rooted tree; it has no big surface root, but is a tall bold tree with a bold head and you cannot get a tree like *Hevea* to grow under the same conditions. The reason why you must have a tall pole for *Funtumia* is that you cannot tap it as you do *Hevea*, down at the bottom; you must tap it at a considerable height because you can only tap it three times in the year. The structure of the bark is different from that of *Hevea*. *Hevea* has a network of lactiferous tissue, whereas in *Funtumia* you have an upright parallel system of ducts which have no connection with each other. If you try to tap as you do *Hevea* you will have "die back" and the death of the tree. Then it has been said that *Funtumia* is a slow grower. It is not an exceedingly slow grower; I should say it is the second quickest grower, *Ceara* being the first. It is only a slow grower in the forest, as every tree is, but it will grow in a plantation more than three times as fast. It was said in one paper that vine rubber was better than *Funtumia*. I think the chemists will agree with me that *Funtumia* is far the better. Mr. Fyffe says the latex gives 33 per cent. of caoutchouc; it is 40 per cent. or 45 per cent. at least. There is no wound response; Mr. Fyffe is quite right in that. As regards tapping, to say the tree is best tapped on the herringbone system or fishbone system

is neither here nor there. It is merely a system of cuts and not of tapping. *Funtumia* has suffered by being tapped by the wrong process; no one has taken up a study of it, but I have been working at it, and have come to the conclusion that you can only tap it by the incision method, and not by excision. If you tap it with a pricker with very thin blade like a razor you can get a clean cut and you get a far better yield and the latex runs much longer; while, what is of more importance, we get practically no injury to the tree. I want to impress upon you that *Funtumia* cultivation is a subject which has been neglected. People are too apt to generalise and think that *Funtumia* can be planted just as *Hevea* can, whereas it belongs to an entirely different natural order.

Mr. FYFFE (in answer to a question): The elevation at which the experiments were conducted was 3,863 ft., and they were all conducted at the same elevation. The trees were planted 12 to 14 ft. apart, and this I consider much too close. I would advocate at least 25 ft. between the trees. With regard to Dr. Christie's remarks, I am confining myself to Uganda and what I have seen in the forest. My experience is that it is a slow grower, both in the forest and in the plantation, and I cannot agree with Dr. Christie. I agree with him, however, as to tapping, and I believe in using a pricker; you do not have to cut so deeply, and therefore there is not so much injury done to the tree and you get better results.

The CHAIRMAN: I should like to ask Mr. Fyffe what he thinks of Dr. De Wildeman's suggestion?

Mr. FYFFE: The trees are so slow growing and the vines so slow growing it is not practicable. You would have to wait a long time to cut them a second time.

The CHAIRMAN: The growth might vary in different regions.

Mr. FYFFE: It does, but it would not be rapid enough to advocate that system.

Mr. F. CROSBIE ROLLS: Has there been any cultivation of *Manicoba* in Uganda?

Mr. FYFFE: No.

Mr. PETCH: I do not know anything about *Funtumia* except that we have a few trees. One point I noticed in the paper was that the trees heavily tapped lose their leaves and many die. That will happen if you tap *Funtumia* all round at the same time. We did it on a system of full spiral. If the discussion is to be general, as it seems to be getting, I might give a few remarks. The *Ceara* tree, as we call it in Ceylon, is grown under rainfalls of from 30 inches to 200 inches and on elevations up to 3,000 ft., and on all kinds of soil, and I really think that somewhere in that range we should reach the proper soil and rainfall. We can grow *Ceara* like a weed, but we cannot tap it. There are several estates in Ceylon getting very good results from *Ceara*, but they tap on the principle that they do not mind whether the tree dies or not. They are cocoa estates with a large reserve of land. They tap the trees by all manner of systems, and if the tree dies they do not mind, for there will be another coming up not many yards away. Up to the present we have not been able to get a tapping system for *Ceara* without killing it. The rubber is in it, there is no doubt. Some think paying crops could be obtained from *Ceara* if the tree were treated in the same way as you treat the Mexican

shrub. The trees must be 18 months to two years old. We can provide you with acres of ground on which you can grow *Ceara* and get a splendid crop in two years if you can cut it down and extract the rubber. You can arrange to do it periodically every six months and the thing will stand it. With regard to the new *Manihot*, we have had it growing for the last two or three years, and we find that if you plant them quite apart you can get a main stem 3 ft. in height—and then the three branches gives you an enormous head, but the first winter breaks it all up. The stem will not carry the head as we grow it in Ceylon. Possibly our ground is too good for it. Up to the present the Ceylon Botanical Department has not sufficient evidence to warrant their recommending any of the new *Manihots* to the planter in Ceylon. I am not at liberty to give you the full history of wide and close planting, but I may say that the present difficulty is entirely the result of following European forestry practice. The first planting of *Hevea* in Ceylon was based on the experience in European forests, and that is why we have gone wrong. If you read the recommendations published in the nineties you will see that the great thing was to get a long, straight stem by planting close together. That was wrong, and we shall have difficulty in changing it. In 1905 they were planting 10 by 10 and 12 by 10, and in 1906 they were planting 15 by 15. In the Straits they were planting at greater distances. You must remember that in the first cycle of tapping very closely-planted trees undoubtedly gave more rubber. The amount of plant food in an *Hevea* stem is large, and whether you plant them wide or close for the first six or ten years you get practically the same result, and you get better bark renewal with close planting because you get a damper atmosphere. Close planting gives the best result in the yield for the first few years, and with the present price of rubber it pays to plant close, but close planting now is 15 by 15, whereas in 1905 it was 8 by 8. So that we have already got to a quarter of the number of trees, and it will not be difficult to get to 30 by 30. We were told that when we want fruit we must plant wide apart. Well, things differ in different localities. I had a friend in the Chelmsford Botanical Station who had a system of growing excellent apples with special pruning. They were 6 inches apart in the row and 18 inches apart between the rows. They got specimen apples from every tree, and it paid to grow them. Of course, we went wrong in the first place, but we are not going to the other extreme because we are not in a good temper. There is another question about the roots. It may be said that the root of a tree, in the tropics, bears no relation to the height of a tree or the spread of the branches. It used to be said that if the roots are outside the limit of the crown the rain drops down from the branches to the root terminals. It is a splendid idea, but does not work. We have in Ceylon 25-year-old *Hevea* trees, and I can trace the roots on the surface for 20 yards. They are 3 inches in diameter below the surface, and I am not quite sure they do not go another 20 yards. Of course, the spread of the crown of the tree is not more than 3 or 4 yards each way. You will find that in every case the spread of the roots is far beyond the crown of the tree. Now, the point I would like to make is that the interference of the roots is of small moment in comparison with the interference of the branches. You can leave the interference of the roots out of the question, because the roots of *Hevea* may run a long distance, but there is plenty of soil between them and the roots of other trees go into that. But the interference of the branches which manufacture the food of the tree is more important.

The Production of Rubber in Madagascar.

By the Colonial Government of Madagascar.

(*THIS PAPER WAS TAKEN AS READ.*)

I.—Natural Stock.

Rubber plants grow in all parts of the island, especially along the coast, except in the Central District, where none grow Merchants established in the island were exporting rubber, obtained from the natives by trading, before the Conquest of Madagascar by the French.

The Madagascar rubber plants are vines, trees or bushes belonging to the family of the *Apocyneae*, *Asclepiadeæ*, and *Euphorbiaceae*, the number of species varying in different districts.

1.—*West Coast.*—The rubber-bearing flora of the West Coast comprises many species. The *Landolphia* family is represented (1) by the *piralahy* or *vahealahy* (*Landolphia Perrieri*) of the Sakalaves. It is a vine which abounds in all the forests of Bouéni, Majunga, as well as in the valleys of Tkopa and Betsiboka. Its diameter at the base may reach from 10 to 15 centimetres. The latex obtained by incision is abundant, acid, white or slightly pink, and easily kept. The Sakalaves work these vines regularly during the rainy season ; (2) the *Reiabo* (*Landolphia Spharocarpa*) dwells in the Sofia and Bemarivo basins. This vine requires a fertile and damp soil, and is, therefore, only found in alluvial plains along the rivers. Its stem is thicker than that of *Piralahy.* It gives an abundant latex, which is white or pink, and is also collected during the rainy season by the Sakalaves, who use lemon juice or a concoction of tamarind fruit for coagulating it.

The rubber obtained is pink, nervy, and of good quality. The abundance of latex in the *Reiabo*, and its richness for coagulating principles give this vine a very great economic value. Ordinary alcohol does not coagulate the latex in the cold, nor does acetic acid unless large quantities are used. Sulphuric acid is more rapid in its action, and at 66° 2 cubic centimetres of this acid will coagulate 50 cc. of latex.

The most advantageous method, however, consists in boiling, after adding a small quantity of acid. While 50 cm. of cold latex are not coagulated by an equal volume of pure acetic acid it suffices to add to this same quantity of latex 1·5 c.c. of acetic acid (or 20 cm. of a 15 per cent. acetic acid solution), and to heat over a fire in order to see the rubber separate from the serum wholesale as soon as the boiling starts.

This process (boiling of latex slightly acidified) seems to be, generally speaking, the best method of coagulating the Madagascar latices, and especially good results are obtained with the latex of the Mascarenhasia.

The West Coast contains three species of Mascarenhasia: *Mascarenhasia Lisianthiflora, Anceps* and *Longifolia*, known by the Sakalaves under the general name of *Gidroa*.

Lisianthiflora is a small tree not over 5 metres high, which seems to haunt the dry hills. It gives a thick latex in small quantities. The natives collect this by making incisions in the stem. The latex coagulates on the wound; the rubber is gathered in threads and made into balls. It has a dark brown colour, is nervy, and of good quality.

Mascarenhasia Anceps is a shrub growing on the banks of the rivers and the lakes. It is common in Bouéni and in the Maovatanana district, but its economic value is comparatively low.

M. Longifolia is a large tree, not very common, growing to a height of 15 to 20 metres, and with a trunk diameter of 40 centimetres. Its latex is abundant and easily coagulated. The rubber obtained is of a very dark brown and rather nervy. The *Asclepiadæa* family is also represented by the *bokalahy* (*Marsdenia Verrucosa*), a plant whose shape varies according to the conditions under which it grows When near a tree it is a vine; when no support is at hand it is a stunted shrub. The latex of *bokalahy* gives a very inferior product.

Another *Asclepiadæa*, the *lombiro* (*Cryptostegia Madagascariensis*) is very plentiful in the basins of the Mahavavy, Betsiboka and Mahagamba. It prefers soils rich in lime, and grows as a vine or as a bushy shrub, according to the presence or absence of a support. It occurs abundantly in several parts of the island (north-east, north-west and south-west), and is particularly abundant in the provinces of Diego-Suarez and Nossi-Bé. It seems to prefer a seashore locality, such as the damp pebbly flats, at the river mouths which feel the influence of the tides. The product varies, as to quality, with the district. In the west, for instance, *lombiro* rubber is slimy, without any nerve, but is of high value in the south-west and the north-east.

Vahimainty (Secamone), a vine of the Morondava district, gives a dark brown product, rather nervy, and of medium quality. On analysis it gives:

Moisture	3·50
Rubber soluble in ether	63·33
Resins soluble in a mixture of alcohol and ether	10·17
Insoluble rubber and impurities	20·62
Ash	2·38

Euphorbia Pirahazo, an Euphorbiacæa, is also found on the West Coast. It grows by preference on calcareous ground, which is rocky and dry, and seldom appears in forests where there is any dampness. The Sakalaves say it grows to a height of 20 to 30 metres, but the specimens one generally finds are not over 12 metres in height and 20 centimetres in diameter.

The rubber it generally produces is brown, supple and elastic. Analysis gave the following:

Moisture	2·50
Rubber soluble in ether	77·02
Resins soluble in a mixture of alcohol and ether	6·31
Substances insoluble in ether	12·87
Ash	1·30

2.—*South and South-West District.*—The South also produces many rubber plants, some of which give a fair quality product. They are mainly small plants, either shrubs or vines.

Angalora (an *Apocynea*) grows in the arid steppes and rocky hillocks of the Cactus zone. The natives gather the latex by making incisions at the foot of the tree after cleaning. This mode of operating necessarily causes dirt and foreign matter to be mixed with the rubber. *Angalora* springs up again with great strength even after the fire has gone over it, and it is easily propagated by setting out seedlings.

Table showing the results of latex coagulation experiments on certain plants of Western Madagascar :—

Plant.	Quantity of Latex.	Coagulant.	Quantity of Rubber Obtained.	Rubber Contents of Latex %	Remarks.
Piralahy or *Landolphia Perrieri*	660	220 cc of 15% Acetic Acid	40 grs.	6·5%	Boiled
Do. do. ..	750	,, ,,	50 ,,	6·5%	,,
Reiabo or *Landolphia Spherocarpa*	550	,, ,,	42·65 grs.	7·75%	,,
Mascarenhasia Lisianthiflora	510	,, ,,	215 grs.	42%	,,
Lombiro or *Cryptostegia Madagascariensis*	700	,, ,,	25 grs.	3%	,,

Another plant, the *Harobahy*, belongs also to the *Apocynæa* family. Its growth is slow, a ten-year-old vine not reaching over 2 to 3 centimetres in diameter. Its rubber seems to be of good quality.

Of all the rubber varieties in the South, the most interseting one by far is the *Intisy* (*Euphorbia Intisy*). This *Euphorbiacæa*, which characterises the flora of the Androy, grows by preference in the shade and protected from the wind, on the wooded hillocks where the soil is dry and stony.

Intisy rubber has a good reputation, being known on the European markets under the name of " Niggers " or " Kiloa."

It is rather difficult to propagate *Intisy*, but in recent years attempts have been made and important seedings started in several places.

Gidroa (*Mascarenhasia lisianthiflora*) is found in the shape of a shrub from 2 to 3 metres high, and generally grows on grassy hillocks. *Lombiro* (*Cryptostegia Madagascariensis*) also occurs in the Southern district.

3.—*East Coast.*—The great Madagascar forest of the East Coast, which extends with scarcely an interruption from Cape Ambra to Fort Dauphin, possesses numerous laticiferous varieties represented sometimes by trees but more frequently by vines.

Vines.—The most common varieties in the forest are *fingibary* (*Landolphia Dubardii*), *Ravinangitra*, *Talandoho* (*Landolphia Madagascariensis*), *fingemera* (*Landolphia Fingimera*), *Fingipotsy* and *Vohena.*

The *fingibary* vine has a very restricted habitat, but its growth is rapid. This *Landolphia* prefers damp localities, but not swamps. It is mainly found in the valleys and the well-shaded ravines, where it grows to a height of 30 to 50 metres, and has a diameter of from 8 to 10 centimetres. It yields an abundant latex which is easily coagulated, and gives a very elastic pink product.

The following table gives the results obtained from the latex of this vine :—

Method of Coagulating.	Volume of Latex in c.c.	Volume of Coagulant in c.c.	Wet Rubber obtained.	Dry Rubber obtained.	Content %.	Remarks.
Boiling	500	—	94 grs.	80 grs.	16	—
5% solution of Citric Acid	500	325	66 ,,	59 ,,	11·5	—
Sulphuric Acid ..	500	110	60 ,,	46 ,,	8·1	—
Absolute Alcohol ..	500	290	64 ,,	46 ,,	8·1	—
5% solution of Nitric Acid	500	100	63 ,,	50 ,,	10	—
7% solution of Bi-chloride of Mercury	500	300	—	—	—	No result
7% solution of common salt	500	170	74 ,,	51 ,,	10	—

Ravinengitra has an extensive habitat. This vine is found to some extent everywhere, but especially in the mountainous zone (800 to 1,200 metres altitude). Its latex is abundant and fluid. The rubber is nervy and very elastic and of first quality. When freshly coagulated it is of a pinkish white, but becomes a brownish red on drying.

Fingimera (*Landolphia Fingimera*) and *Fingipotsi*, which are two vines having the same habitat, in the medium zone (from 100 to 800 metres altitude), give a supple elastic gum of good quality.

According to several writers, the *Talandoho* is *Landolphia Madagascariensis*. It lives essentially near the Coast, and does not exist in the mountain and medium zones. It gives a rubber with comparatively little nerve.

The results of coagulation experiments on the latex of these two vines are given in the following table.

Name of the Vines.	Coagulant used.	Volume of Coagulent in c.c.	Volume of Latex in c.c.	Weight of Dry Rubber obtained	Remarks.
Talandoho	2% Sulphuric Acid sol.	150	1,000	85 gr.	Becomes resinous in drying
	10% Citric Acid ..	200	900	90 ,,	Does not become resinous
Fingimera	2% Sulphuric Acid sol.	150	1,000	70 ,,	Dark brown in colour
	10% Acetic Acid sol.	200	500	35 ,,	Yellowish in colour
Fingipotsy	2% Sulphuric Acid sol.	100	700	45 ,,	—
	10% Citric Acid sol.	200	500	35 ,,	—
Ravinengitra	2% Sulphuric Acid sol.	50	300	20 ,,	—
	10% Citric Acid sol.	200	600	45 ,,	—

The East Coast vines produce the rubber which goes to Europe under the name of "Pink Tamatave," or "Pinky Madagascar."

Trees.—The rubber trees are not so well represented as are the vines. There are only two species belonging to the *Mascaranhasia* family : *Lisianthiflora* and *Anceps*.

They are called *hazondrano* (*babo*), or *barabanja*, by the natives.

Lisianthiflora grows in high regions (800 to 1,200 metres altitude), hence the name *hazondrano*, which means "of the heights."

Anceps ("hazondrano of the lowlands"), on the other hand prefers damp soils and is therefore generally found in the valleys along, the rivers and in the swamps—sometimes in extensive plantations.

The trees are sometimes from 10 to 12 metres high and 25 to 30 centimetres in diameter. Their latex is thick, rich in rubber, and easily coagulated at ordinary temperatures, giving a dark brown rubber which is elastic and of good quality.

Finally, it is necessary to mention a just recently discovered Sapotacæa—*vatodinga*, probably belonging to the Mimusops family. It is a tree from 12 to 14 metres high and from 30 to 40 centimetres in diameter, and found on the banks of seacoast rivers. This variety supplies a greyish white gutta which is supple but inelastic, and is marked with distinct stripes. The Payen method gave the following results for two samples coming from different districts :—

	Impurities.	Albane.	Fluviale.	Pure Gutta
Sample I. ..	.. 3 %	0·4%	14·2%	82·4%
Sample II. ..	.. 1·4%	0·8%	10·2%	87·6%

Unfortunately, the insulating properties of the Madagascar gutta are comparatively weak; they might perhaps be improved by the admixture of appropriate compounding materials.

Madagascar gutta, like ordinary guttapercha, is plastic when warm and capable of being stamped. For this purpose a temperature of 65 to 70 degrees is sufficient.

Propagation of the Native Rubber Plants.

The most advantageous methods of repleting the stock of rubber vines is now being made the object of study at the forest station of Analamazaotra (East Coast). On the other hand, rubber-bearing reservations have been created in the West for the benefit of the native villages. The high parts of the forest areas have been planted with *Piralahy*, and the low parts with *Gidroa*, the very damp ones with *lombiro* and *bokalahy*. The vine plantations are therefore bound to become of great importance to the Colony at an early date.

II.—Rubber Tree Plantations Established by Europeans.

The cultivation of the rubber-bearing varieties in Madagascar is at present conducted on a small scale. Statistics, undoubtedly approximately accurate, show that the rubber-bearing plantations at the end of 1908 covered a surface of about 320 hectares, distributed as follows :—

West Slope.. ..	Diego Suarez ..	200 hectares
	Nossi-Bé	10 ,,
	Analalana ..	20 ,,
	Majunga	20 ,,
	Mœvatanana ..	250 ,,
East and South East Coast..	Vatomandry ..	43 hectares
	Farafangana ..	70 ,,
	Andevorante ..	7 ,,
	Mananjary ..	200 ,,

The Diego Suarez plantations cultivate the *lombiro* (*Cryptotagia Madagascariensis*) almost exclusively; the others only contain *Ceara* (*Manihot Glaziovii*). *Hevea Castilloa*, *Ficus Elastica*, and *Funtumia Elastica* are represented in several parts of the island by a certain number of specimens, but there are, strictly speaking, no plantations of these trees.

All the rubber plants tried in Madagascar have generally come on well; they are all thriving and bearing fruit these last four or five years.

Manihot Glaziovii has been set out in rather important plantations—some of the trees are now 10 to 12 years old. Up to the present moment it has not been found possible to work this variety economically, and it seems certain that in Madagascar as everywhere else it is not going to pay those who devote themselves to its cultivation. M. Perrier de la Bathie's experiments last year at Maravony, on the plantation of M. Shizanski, gave better hopes for the cultivation of the Ceara. Four to eight-year-old trees, tapped during four months only, have given an average of 126 grs. of remarkably good rubber. Unfortunately these good results are not forthcoming again this year, and the hopes which these tapping experiments seemed to warrant still await their realization.

The oldest *Hevea* tree in Madagascar must be about ten years of age. Those of the experimental station of Tooloina are only seven years old. Up to the present these trees have not been submitted to any methodical harvesting experiments, but the few haphazard cuts which have been made on them have shown that they yield a latex which gives excellent rubbber.

Castilloa was introduced in 1901. The oldest specimens of this variety in the island are those of the experimental stations of Tamatave. They were planted in 1902 and 1903, and are now from 10 to 12 metres high, the trunks of some of them measuring nearly 50 centimetres in diameter at the base.

Ficus Elastica has existed in Madagascar for ten years. The Tamatave station has two ten-year-old specimens, whose stems are about 50 centimetres in diameter. These trees have never been tapped, but it is known that they produce a less nervy and less elastic rubber than *Hevea* and *Castilloa*. Other five-year-old trees have developed very satisfactorily.

Funtumia Elastica.—The first *Funtumia* was introduced in Madagascar ten years ago by the Museum of Natural History. This first specimen is now 8 to 9 metres in height, and its stem measures about 18 centimetres in diameter. *Funtumia* seeds gathered at the Sainte-Claire station (Trinity) were sent to Madagascar in 1902.

The trees from these seeds have been planted at the Tuvolvina station; they are 6 to 8 metres high and have borne abundant fruit for several years.

The ten-year-old *Funtumia* was tapped for the first time two years ago and gave a good quality rubber, but a very small quantity.

Tapping Experiments.

The first experiments on the extraction of rubber from cultivated trees in Madagascar were tried in the latter half of 1910.

The *Castilloa* trees at the Tamatave experimental station have given, in one tapping, 271, 115 and 236 grs. of dry rubber. These

trees, which were tapped in V shape, are eight years old, 13 metres high, and average 35 centimetres in diameter 0·20 m. above the ground.

Experiments on *Hevea Brasiliensis* have been tried in the province of Viomandry. The tapped trees are ten years old, they are 12 to 14 metres high, and their trunks 0·81 to 1·10 m. in diameter one metre above the ground. Seven trees planted in damp alluvial soil have given 1,998 grs. of dry rubber. The tappings made by the "fishbone method" on one side of the stem have been revived 14 times at 48 hours intervals.

The same facts have been noticed as in the Far East, namely that the amount of latex obtained increases from the first tapping up to the last one. This increase is very strong in certain trees, the yields ranging from 6 cubic centimetres of latex obtained the first day to 190 on the twenty-eighth.

The richness in latex varies also very much with individual trees. One, in fact, yielded 1,601 cubic centimetres of latex, while another one, subjected to the same treatment, yielded only 210 cubic centimetres. Here, then, is a most valuable indication to the planters to guide them in the choice of the seeds and to show them the necessity of seriously selecting the seed from which trees are to be raised.

The nature of the soil also seems to play an important part in the amount of latex yielded by the trees. Five trees on the same estate as the last-mentioned but planted in soil formed of laterite have only supplied 329 grs. of dry rubber. True, the development of these trees is not as far advanced as that of the others, their diameter one metre from the ground averaging 74 to 85 centimetres.

The individual richness of these trees in latex has also proved itself very variable. One of them in fourteen tappings only gave 14 cubic centimetres of latex, against 346 yielded by another.

Conclusions.

From these two scanty experiments and from what can be gathered from observation of the trees already existing on the East Coast of Madagascar, one can conclude that the alluvial soils suit *Castilloa* and *Hevea* perfectly and that those trees properly cultivated seem to yield harvests which compare with those obtained in the countries where they are cultivated regularly. The necessity of a rigorous selection of the seed-bearing trees stands out very distinctly also, and certainly forms the most important result of the above-mentioned experiments.

III.—Preparation of Rubber.

(*a*) *Native Process.*—The Sakalaves on the West Coast work the *Landolphia* by cutting the stem and branches up in short sticks and letting the latex drip from them into a dish. They coagulate the latex by adding lemon juice to it, or else a concoction either of fruit pulp of the tamarind tree or of rhizomes of the *Vahea mongary* or *Vahea lava*, which is a vine of the Menispermea family (*Anisocyla Grandidieri*).

The Sakalaves do not prepare *Gidroa* (*Mascarenhasia*) rubber as they do vine rubber. They no longer cut the branches to gather the latex, but make numerous incisions in the trunk of the tree during the dry season, when the latex is very thick but not plentiful. The latex coagulates almost immediately under the wound in the shape of strips, which the harvesters stick together in balls.

Trees No.	Circumference of the trees measured 1 metre above the ground.	Yield of Pure Latex in Cubic Centimetres.														
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Tot.
	m.															
1	0·73	1	—	2	5	8	12	12	15	25	25	25	26	27	27	210
2	0·73	—	—	—	—	—	—	—	2	2	2	2	2	2	2	14
	0·85	4	—	1	—	5	23	26	10	12	12	15	15	15	15	153
1st group.																
4	1	13	7	10	10	10	10	30	35	40	45	45	45	45	45	346
5	0·74	6	15	5	10	10	11	11	15	15	15	15	15	15	15	173
Total in Cubic Centimetres		12	28	15	25	33	56	59	72	89	94	102	103	104	104	395
Total in grammes of rubber put to dry		10	15	9·5	14	18	26	25	35	47·5	50	58	60	60	65	483
Total of dry Rubber		10	7	8	12	16	17	17	25	27	29	32	34	34	37	305
Total of coagulated rubber gathered from the trees		—	6	18	—	—	—	—	—	—	—	—	—	—	—	24

Trees No.	Circumference of the trees taken 1 metre above the ground.	Yield of Pure Latex in Cubic Centimetres.														
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	Tot.
	m.															
6	0·905	6	28	35	40	60	75	85	174	174	179	185	185	185	190	1601
7	0·965	10	10	17	22	23	25	30	55	55	57	60	60	60	60	526
8	0·88	10	10	20	25	26	28	50	60	60	62	65	65	65	66	617
9	0·975	6	15	10	15	20	30	40	63	63	65	70	70	70	72	609
10	0·81	—	—	2	5	5	5	13	22	22	23	25	25	25	26	248
11	0·90	1	5	5	5	6	7	17	21	21	21	25	25	25	26	210
12	1·12	10	39	42	45	50	60	66	70	70	70	75	75	75	76	823
Total in cubic centimetres ..		43	112	131	157	190	230	301	465	465	477	505	505	505	518	4604
Total in grammes of rubber put to dry		28	71	90	112	130	165	185	280	280	290	295	296	296	300	2818
Amount of dry rubber ..		30	40	64	65	85	90	116	155	155	160	175	175	175	180	1666
Amount of rubber coagulated on the trees..		27	22	6	9	35	15	24	21	32	32	27	26	16	20	312

Tappings carried out every other day.

Analysis Results on Rubber Grown on Plantations.

	Hevea.	Funtumia.	Ficus Elastica.	Castilloa.	Ficus Vogelii.
Inventory Number ..	90	88	87	—	—
Moisture	11·95	19·09	4·77	4·77	4·23
Matter soluble in water and solid impurities ..	0·54	—	—	1·01	3·27
Resins	4·24	5·92	21·69	25·80	51·37
Ash	1·13	1·80	1·06	0·52	0·67

The Southern natives cut the vines or the bark of the trees into fragments from 40 to 50 centimetres long, which they gather in small bundles, and expose to heat in order to coagulate the latex. These bundles are then allowed to decay for about a fortnight in a pool of water, after which they are crushed, pounded and washed in flowing water. The operation is repeated several times, until the rubber ball contains no more impurities.

The Eastern Batsemesaraka use a process to extract the latex from vines which differs but little from the one used by the Sakalaves. They cut them up in sticks from 0·60 to 0·80 m. long and place them over an inclined trough generally made of *ravinala* leaves and supported by a lattice of little sticks disposed vertically. The latex is gathered in a bamboo.

When the dripping ceases the ends are cut up again in lengths of 20 to 30 cm. and drained again until all the latex has been exhausted. The natives then coagulate this with common salt or with sulphuric acid, which they can easily get from the Chinese merchants.

A new process has been adopted lately by the natives in the preparation of the *Hazondrano* rubber.

The tree is felled and its bark stripped throughout its whole length; the bark is placed over a brisk fire and dries up while the latex coagulates. The bark is then crushed in rice mortars and washed in hot water. After several successive washings and crushings the rubber particles come together and form a ball.

The natives are very partial to this process, which, it seems, brings them appreciable profit. However, no matter which process is used the native cannot generally make the plant give up the whole of the rubber it contains, neither has the rubber the desirable degree of purity.

(*b*) *Mechanical Process.*—West Coast traders have in recent years used scientific processes from the preparation of rubber.

The rubber is purified by a mechanical treatment and a washing in running water. The machinery also allows the treatment of the vine bark after it has been drained.

These methods have given maximum returns, and a first quality rubber and will very soon spread to other parts of the island.

IV.—Trade.

From the facts that have been set forth here one can form an idea of the wealth of the rubber-yielding flora in this colony. The rubber exported from Madagascar comes altogether from native stocks. Its production will increase as the plantations grow larger. On the other hand better methods of preparing the rubber will cause the prices to go up.

Review of the Madagascar Rubber Markets and Prices.

The rubber from the different districts of Madagascar is sold on the European markets under very different names:—

1. The rubber which seems to command the highest price comes from the East Coast, and is probably extracted mostly from the *vohahena* (*Landolphia Madagascariensis*) and the *fingitra*. This rubber is sold in the shape of pink leaves generally dry. They are called "Pinky Madagascar" in London and Hamburg, and "Rose Madagascar" on our French markets.

2. Then comes the "Black Madagascar," or Tamatave rubber, supplied by the *hazondrano* of the East Coast forest. This rubber is generally damp.

3. "Madagascar Niggers" is marketed in balls and gives light sandy-coloured leaves. The yield on washing and drying only averages from 35 to 55 per cent.

"Madagascar Niggers" is nothing but a mixture of Southern *hazondrano* and *Tafisy*. These balls are adulterated often, which means that the production of these rubbers has never been very great.

4. "Majunga rubber" comes from the vines of the West Coast and from the *Mascarenhasiæ*.

5. *Lombiro* which comes from Diego and Nossi-Bé, and—

6. *Gidroa* (*Mascarenhasia Lisianthiflora*).

are now sent to the markets of Bordeaux, Marseilles, Havre, London, Hamburg and Antwerp.

LECTURE ON THE WEST INDIES,

By F. A. STOCKDALE, Esq., B.A., F.L.S.

[NOTE.—This lecture was given and illustrated by lantern slides, at the close of the West Indian Committee Dinner on the 5th July.—ED.]

The Government being convinced of the suitability of very large areas of the colony for rubber cultivation, have established experiment stations in different districts of the colony to ascertain what rate of growth is made by various rubber-producing trees upon types of soil commonly found in the colony and what cultural methods give the best results. The earliest trials were made with a few trees at the Botanic Gardens and Promenade Gardens, Georgetown. In 1902 planting of Para rubber was commenced at Onderneeming Experiment Station on the Essequibo River, and further planting has been done from time to time. The land at Onderneeming is a fairly rich clay, but there are certain parts of the station that have soils varying from sandy loams to sands. Experience has shown that the rate of growth in the sandy soils has been only about half that of trees of similar age panted in well drained clay soils. The slide now shown illustrates trees at *Hevea Brasiliensis* 4½ years old growing amongst coffee at Onderneeming. Several of the older trees have flowered and seeds have been obtained from them. Tapping has recently been commenced on the larger trees. At Christianburg, on the Demerara River, two acres of rubber were planted in 1906 on soils which are representative of the soils of great areas of the upper parts of the Demerara River district, and since then a further 20 acres have been planted. The Para rubber looks particularly promising on the heavier lands near the river and along creek lands that are not subject to flooding. Another slide showed good growth being made in the sandy loams, but on the sandy soils the rate of growth has been slow.

Some slides illustrating *Sapium* rubber were shown, and the lecturer said the presence of rubber in the British Guiana forests has been known for a considerable time, for the Aboriginal Indians obtained scrap ard wound it into balls for their games. It was not until 1905 that the cultivation of *Sapium Jenmani* was seriously considered, when planting was commenced on some of the lands in thé north-western district that had been thrown out from provision crops. *Sapium Jenmani* is very common in this district, and seeds and seedlings were readily available. Systematic planting was commenced on two properties, and shortly afterwards numerous grantholders began to plant up some of their vacant lands. These plants grew vigorously and soon a keen interest was taken in the possibilities of this district for rubber cultivation. Plants of *Hevea Brasiliensis* were obtained, but owing to the availability of large quantities of seedlings of *Sapium Jenmani*, the greater area, in the earlier stages, was planted with the latter rubber-producing plant. The *Sapiums* that

are cultivated in the north-western district are now fruiting regularly, and it has been ascertained that two distinct kinds are to be found in the cultivations. They are very closely allied and both appear to yield a high-grade rubber. Light tappings are now being commenced and shortly information in regard to yields of these cultivated trees will be available.

Experiments have been tried in various districts with *Castilloa Elastica*. The results have not been generally satisfactory, for whereas a few trees in sheltered situations have grown well and appeared to show some promise, the majority have made but very slow growth and in many instances have died out entirely. The slide now shown is of *Castilloa* trees about 3 years old, growing in well-sheltered situations at plantation Anna Regina, Essequibo. Other large trees are to be found in the Promenade Gardens, Georgetown, and a few fairly satisfactory ones at the Experimental Station, Issororo, north-western district. *Castilloa* in British Guiana suffers from attacks of scale insects, which considerably check its growth. The general experience with *Castilloa* in the colony, however, indicates that it is likely to fail to make satisfactory growth. It prefers hot, well-sheltered valley lands, and possibly it may be found suited for some of the valley lands in the interior of the colony. For the large area of land suitable for rubber in the easily accessible districts it cannot be recommended, especially as Para rubber has been found to grow satisfactorily. Further experiments with different varieties of *Castilloa Elastica* are shortly to be made in various districts of the colony in order to ascertain whether there is any variety that is likely to give more favourable results than that already experimented with.

Funtumia Elastica has been tried at the various Experiment Stations. At Onderneeming, Essequibo, six and seven-year-old trees exist, and some of them have been tapped. The growth has been fairly satisfactory, although it was slow in the early stages. The tapping results, however, were not favourable. The quality of the rubber obtained was good, but the quantity obtained was small. These trees fruit regularly, and produce an abundance of seed. Other old trees exist at Plantation Noitgedacht, on the Demerara River, and tapping of them is now being commenced. Young plants put out in the coastal region have barely grown at all. They have been attacked by scale insects and many of them have died. On the lateritic hill slopes at Issoror Experiment Station in the north-western district, better results have been obtained. One slide showed a young plant of *Funtumia* at slightly less than two years of age. Their growth has not been so regular as could have been wished for, and there has been a tendency for the plants to become bushy. Pruning has had to be carried out from an early stage. Several species of *Manihot* have been experimented with, but at all stations the results have been unsatisfactory. Some fairly large trees are growing in the Botanic Gardens, Georgetown, from which seed is regularly obtained, and some interesting slides were shown. At Dadanowa, Rupununi, situated near the Brazilian boundary, on the Savannah area of the hinterland of the colony, the growth of *Manihot Glaziovii* has been very good.

The trees from which *balata* is obtained are found growing all over the colony, particularly on the lower lands along the banks of the smaller rivers and creeks. They are perhaps more abundant in the county of Berbice, but large forests also exist on the upper Essequibo River. They may be found scattered throughout the forest or they may occur in

reefs, composed practically of *balata* trees alone. In the county of Berbice, especially in the Canje district, the *balata* collecting industry has been fairly established for the past 30 years, and practically all the male inhabitants in this district are engaged in it. They go into the forests during the collecting seasons, returning to their homesteads on the banks of the Canje Creek in the off-seasons. The demand for *balata* has greatly increased during recent years and its value is steadily advancing. The *balata* collecting industry is, judging from the value of the exports, now the third most important industry of the colony, and it affords employment of a considerable number of collectors. It is generally thought that there are two kinds of trees from which high-class *balata* is obtained, but this has not yet been definitely decided.

Tapping of *balata* is done by a cutlass, and begun at the base of the tree, and the cuts are made up the trunk of the tree, often to the height of the principal branches. A calabash is fixed at the base of the cuts for the collection of the latex, and the tricking of the latex between the trunk and the calabash is prevented by means of wet clay or earth. The cuts are made to a height of about 6 or 7 ft., while the collector is standing on the ground. These are then continued by his standing on a roughly constructed bush ladder, while greater heights are reached by means of the rope or by means of the stirrup (as shown on the screen). Frequently the ladder is dispensed with, especially where the trees are somewhat scattered, as it is difficult to carry even these short ladders for any distance through the tropical forest. Some bleeders prefer the rope alone, while others are partial to the stirrups. The latex runs zig-zag from cut to cut down into the calabash at the base of the tree. It is collected from these receptacles in gourds (goobees) or kerosene tins, and it is then taken to the camp, where it is poured into the dabree. These dabrees are generally made from pieces split from the stem of the tooroo palm (*Œnocarpus Bacaba*). They are firmly fixed to a frame and the bottom of the tray is made of strips of this palm laid closely together and braced in position by a rough kind of dove-tailing. The crevices between the palm strips are filled up with damp clay or earth, which is allowed to bake in the sun, and then a thin layer of *balata* is allowed to coagulate over the surface in order to make the tray water-tight. A shelter is then constructed of palm leaves to the windward side of the dabree to protect it from rain. The dabrees are 6 to 8 inches deep and generally hold from 5 to 30 gallons of latex. The latex is allowed to coagulate naturally in these trays. The *balata* is then taken off in sheets, successive sheets being removed until the trays are empty with the exception of the mother liquor. Further latex can be added without detriment if any balata exists in the latex already in the dabree, and this is frequently done. These sheets of *balata* are hung up first over the dabrees to drain and then in a roughly constructed drying shed until they are dry enough to be dispatched to town. Care has to be taken that water is not introduced into the dabree while coagulation is being carried out or otherwise the colour of the *balata* is considerably darkened and coagulation retarded. Another slide gives an excellent idea of a *balata* leader's camp. The dabree with a sheet of *balata* was recently taken from it as depicted, while other sheets were drying in the shelter to the left. The yield per tree varies considerably, the flow being affected by changes in meteorological conditions. Trees average about one gallon of latex each, equivalent to about 5 lb. of dry *balata*, but yields

in favourable seasons of 5 gallons of latex, equivalent to 25 lbs. of *balata*, are said to be obtained. The cuts made in the bleeding of *balata* are stated to take four or five years before they are entirely healed, and as no tree may be retapped before the incisions are completely healed, that period has to elapse before retapping can be done. The first sample of *balata* from British Guiana was sent to London in 1859. The reports received from manufacturers were not satisfactory, and therefore no further interest was taken in the subject until 1862, when Sir William Holmes, the Commissioner that represented British Guiana at the International Exhibition in London of that year, brought the substance into prominent notice. Samples were submitted to several manufacturers for examination, and the merits of *balata* appear to have become recognised, as a demand was created. In 1865 over 20,000 lbs. were exported. From that year, however, the trade fell off until 1874, but subsequently it gradually recovered, and in 1888 a very large increase in the exports took place, as much as a quarter of a million pounds being exported. The condition of the industry improved up to 1907, when the exports increased enormously. During the financial year 1908–9 the maximum export of 1,090,405 of a value of £98,128 was recorded, but it is probable that this export will be considerably exceeded during the present nine months of this year 1910–1911 have been 1,086,214 lbs., as compared with 979,426 lbs. for the same period last year. An export tax of 1d. per lb. is now collected on all *balata* exported.

With regard to Crown Lands available and terms of leases of the 52,777,000 acres of land in the colony, 36,401,000 acres are forest-covered hilly and rolling lands. Of the balance it is estimated that 10,880,000 acres are easily accessible, and fully 9,000,000 of these are unalienated from the Crown. Much of this is suitable for rubber cultivation and for growth of other tropical products.

The West African Varieties of Latex and Raw Rubber.

By M. C. HUGOT,

Lecturer at the University of Bordeaux.

The West African varieties of raw rubber occupy a good position in the European markets. During February, 1911, the price of Para being 19·50 frs. or kilog, the following prices were quoted for the African varieties at Bordeaux :—

Konakry Niggers	14·00 to 14·25 frs.
Rio Nunez	14·50 ,, 14·75 ,,
Red Sudan Niggers	12·25 ,, 13·50 ,,
White Sudan Niggers	11·75 ,, 12·25 ,,
Sudan Mariohs	14·50 ,, 15·00 ,,
Lahou Niggers	11·25 ,, 11·50 ,,
Lahou Small Cakes	10·25 ,, 10·50 ,,
Lahou Medium Cakes	9·75 ,, 9·50 ,,
Bassam Lumps	6·75 ,, 10·25 ,,

At the time this lecture is being written, raw rubber prices have gone down considerably, but the same scale of prices, as compared with Para holds good.

We are quoting these figures as a proof of the tangible value of the West African raw rubber varieties, and the criticisms set forth in this lecture as to the methods of coagulation and preparation, are the result of careful observation, and are not at all intended to diminish the market value which the manufacturers attach to the West African rubber varieties.

The conclusions to which our studies have led in this particular case may sometime be found of general utility.

We do not intend to give here a description of the African rubber varieties ; neither shall we speak of the experiments on the systematic cultivation of these varieties, nor yet of the best way of choosing good yielding trees. We leave all this to M. Auguste Chevalier, who has treated this subject with a competence based on a ten years' study in Western Africa. He has given us precise information as to the experiments made on the cultivation of the *Gohine* vine, or *Landolphia Hendelotii*, as well as *Funtumia Elastica* in French Western Africa. Very serious experiments have been made in Belgian Congo, there having been about 3,460,800 *Funtumia Elastica* trees planted. They are now from 7 to 9 years old and the rubber they produce is said to have sold at from 17 to 20 frs. per kilog. in Antwerp.

M. Chevalier has also told us that the planting of *Hevea* has been tried in French Western Africa, but the experiments are not far enough advanced to warrant discussion of the results. *Ceara* trees under cultivation have not given good rubber. In Belgian Congo the State has planted something like 30,000 *Hevea* trees, whose development must be observed before any practical conclusions can be drawn.

West African Latices.—The latex of the West African rubber varieties varies somewhat in composition according to its origin. It contains water, rubber, mineral salts, albuminoids and resins. Its composition varies not only with different varieties of latex, but also in samples from the same tree. It is impossible to compare the results of different analyses unless, in every case, the vital questions of the climate, soil, dry or wet season during which the sample has been taken, the part of the tree (stem, branch, or root) which has been tapped, even the hour of the day when the latex was gathered, are taken into account. Other conditions, too, may influence the composition of this liquid. The whole subject is in a very hazy condition.

For instance, here is the analysis of a sample of latex from an African *Funtumia Elastica*, published by Dr. Spence at Liverpool :—

Water	56·9	per cent.
Rubber	36·53	,,
Resins	4·16	,,
Mineral matters and albuminoids ..	2·88	,,

Analyses of latex from the *Landolphia Hendelotii* give different proportions.

Here is another analysis of latex from *Hevea* :—

Pure rubber	31·70	per cent.
Albuminoids	1·90	,,
Organic colouring matters	7·00	,,
Water, acids	56·37	,,
Substances dissolving in water	2·90	,,
Resins	0·73	,,

Other authors have found 42·62 per cent. of rubber in *Hevea* latex. Preyer, examining the latex of *Ficus Elastica* in Java, finds rubber 42·80 per cent. ; while Van Romburgh finds from 40 to 44 per cent. of rubber in latex from the same source.

It must be remembered that the analysis of latex is a delicate operation, involving methods not yet thoroughly tested. In most cases the sample is analysed a very long time after the harvest. For all we know changes and reactions unknown to us may alter the original composition. The analysis we have given of the *Funtumia Elastica* latex was made on a sample which was transported without any apparent modification through the introduction of an antiseptic.

It is, therefore, evident that for the present the analysis of a latex does not give a safe basis on which to prescribe a rational method of coagulation. All those who have studied these questions, whether theoretically or practically, have been guided mainly by empirical data. This being so, let us remain on experimental grounds and see what the facts teach us. As we have said before, our study deals with the African latex, in particular with the latex from the *Gohine* vine. But we think that our conclusions may be worthy of general consideration, and that they may apply more or less to the preparation of all varieties of raw rubber.

African Methods of Coagulating the Latex of the "Gohine Vine (or "Landolphia Hendelotii").

Raw rubber from this plant is prepared by the natives, either by empirical methods invented by themselves, or by methods instituted by Europeans.

In most cases the natives coagulate the latex by means of a coagulant extracted from certain plants. Sometimes they use salt water, and very often they bring about spontaneous coagulation.

The raw rubber from these districts is either called "Niggers" or "Twists," according as the coagulation has taken place directly on the vine, or has been performed on latex gathered in dishes.

Niggers.—In this case the native makes an incision on the stem or branches of the vine, which allows the latex to leave the ducts in which it is stored. The native then wets the incision with a coagulating solution, which coagulates the thin stream of latex as soon as it appears into elastic strings. These are pulled off, pressed in the hollow of the hand and shaped into a coarse ball. Around this nucleus then the native winds the product of his labour and forms a very large ball. It is their appearance which caused these balls to be called "Niggers."

Twists.—In this process the native gathers the latex coming from incisions in the vine, in calabashes, then coagulates it by adding extracts of various plants. He draws the raw rubber out of the dish in the shape of strips or thongs, which he also winds up in balls.

The coagulants employed by the native vary greatly in their nature.

He often uses a decoction of native sorrel, called *da en Bombara*, which is found in all the villages. Decoctions of *periférini* leaves or twigs, tamarind leaves, or more especially seeds, or *Utimo en Bombara.* Niama leaves (*Banhinia Reticulata*) are also used. M. Chevalier at first advocated the use of the leaves of this tree, which is spread very widely over Western Africa, but it has been found that rubber thus prepared is not always of good quality.

A certain amount of lemon juice in water is also often used as a coagulant. Sometimes the native simply squeezes the lemon over the latex, letting fragments and pips fall in as well as juice.

Finally a number of coagulants once used by the natives have been discarded, such as *diebe* leaves, guava leaves, and fragments of baobab fruit. The latter product causes the rubber to be of no use.

The preparation of rubber in balls tends more and more to disappear in French Western Africa. Under the influence of the campaign we have led, thanks to the native schools created by the Government in different centres, the rubber is prepared in slabs or strips, easy to clean and to dry, and which render frauds impossible.

The above-mentioned coagulants, lemon juice, decoctions of leaves, etc., give good rubber. Everything depends, as we have shown, upon the method of preparation. We have even found out by coagulations made on the spot that the rubber prepared with lemon juice, either diluted, or mixed with a decoction of *da*-leaves, was as good in quality as the rubber obtained by coagulating the latex with pure citric acid, or a water solution of crystallised oxalic acid. The quality of the rubber depends largely on the care taken in the washing and drying.

In certain districts the natives use salt water—even sea water. Rubber made in this way has come in for some criticism. We have ascertained on the spot that rubber obtained by a solution of salt has to be very carefully washed and dried in the shade. Where these precautions are not taken, the rubber easily becomes sticky. The less pure the salt used, the more accentuated this fault becomes, thus the coagulation with sea water gives a bad quality rubber.

All the preceding methods come under the head of chemical coagulants, whether mineral acids and inorganic salts, or organic acids and plant extracts.

Chemical coagulation is also used in other countries where rubber is a regular industry.

In Maranhao and Matto Grosso, dilute sulphuric acid has been used for quick coagulation. It is still in use, but its results are not very satisfactory, because this acid seems to have an evil influence on the nerve of the rubber. Sea salt has replaced the sulphuric acid in both these provinces. Alum has been used in Pernambuco and Maranhao to coagulate *Hancornia* latex, but the rubber thus prepared deteriorates rapidly and requires washing.

In Peru, the *Hancornia* latex is also coagulated by soap-water, the mixture being churned to accelerate the coagulation ; this is almost a sort of a cream separating process.

In Ceylon and the Straits the latex of *Hevea Brasiliensis* is coagulated by the action of acetic acid. Creosote dissolved in alcohol has been added to the acetic acid. The latex being alkaline, just enough acid is added to make it slightly acid. After this addition the rubber separates rapidly. The use of creosote has soon been given up, since it lessens the nerve of the rubber. Even the use of formic acid has also been contemplated. Latex that has been strained is now coagulated in the Straits, in from 8 to 10 minutes. Previously an ice-cold solution of 2 per cent. acetic acid was added to a vat of latex. The coagulation process took 5 hours. The new system consists in using 5 to 6 times more acid than in the previous one, which means 5 grams of acid per 672 c.c. of water.

The thick but bulky coagulum is put under the press, washed and plunged for half an hour in warm water (170 to 180 deg. Fahrenheit) containing some formol. The round or rectangular slab obtained by this process is put to dry in a well-aired room. It has been ascertained that rapid coagulation gave a superior product. It has also been noticed, as we have insisted in the case of the African rubbers, that no matter what coagulation method was used, it was essential to eliminate from the gum all traces of impurity. Therefore, the lumps are cut up in large pieces and thrown into a set of washing or cutting cylinders, which tear them in small irregular fragments, while they are washed by a very abundant continuous current of water. By sending the rubber three or four times through these cylinders, it is washed very perfectly. The washed rubber is passed between finishing or moulding rollers which press it and stretch it at the same time, giving it the required thickness and length. One gets, for instance, pieces from 3 to 8 ft. long, whose thickness goes from 1 to $1\frac{1}{2}$ centimeter. These are the "sheets." If rolled thinner by greater pressure, one gets "*crépes*" in very thin ribbons 8 meters long. The sheets and crepes are afterwards dried in the air or in the vacuum. Great care is taken in the drying.

Sometimes the latex from certain vines of the *Apocynea* family is used to coagulate other latias. M. Auguste Chevalier mentions the coagulation of *Funtumia* latex by the latex of the *Strophantus Barteri*. The Aguis, according to M. Chevalier, use the sap of another variety of the same family, *Strophantus Sarmentosus*, but the latter has so great a coagulating power that it must be used diluted. Finally, in Tudénié, the latex of two kinds of *Alafia*, which are yet undefined, are used for the same purpose and are mixed with the latex from the *Strophantus*.

A good number of chemical coagulants have been proposed, but they very often have the disadvantage of being difficult for the natives to handle, and they do not always produce a superior quality rubber.

Other Coagulation Methods used in Africa or Elsewhere.

In certain districts, especially the Congo, the method of crushing or threshing the vegetable tissues, is being employed. This is more or less successful according to the districts and conditions of exploitation. Three distinct cases are to be considered : according as the raw material consists of the waste of branches, of pulled-out roots, or of the rhizomes from herbaceous plants (the so-called " grasses ").

This process may be applied, for example, to the rather strong roots of a rubber vine of the dwarf variety, which are found in certain African regions such as the Senoussi land. These roots have a bark which is rich in rubber yielding latex. The botanists, especially M. Chevalier, consider this vine to be a *Landolphia*, whose aërial parts are kept from developing through the periodical bush fires.

The roots and rhizomes are pulled out, cut according to length, and put to dry in the sun. Experience only can give the time required for the drying. Then the roots are soaked in water for some days. The coagulated rubber is " threshed out " with sticks and gathered up. Sometimes mortars are used, which the native women or the children can work. The purpose is to get rid of the waste bark and wood, which is accomplished by crushing, followed up by washings in water. The rubber, which is more or less spongy, is pounded to get the water out of it, then put to dry in the shade.

In certain cases in the Congo, attempts have been made to replace native labour by machinery, but operations in some cases ceased for the lack of raw material.

In Mexico, a similar method is used for extracting " Guayule " rubber from *Parthenium Argentatum* shrub. But the crushing of the fragments of the plant is not enough. It is completed by a series of chemical treatments with which we do not propose to deal.

Let us now consider what we may call " separation methods." In the first of these the addition of water brings about separation, which is followed by draining, washing and compression. Generally, water is added to the latex and left to stand for a certain time. This is the way certain natives of the Ivory Coast treat *Funtumia* latex. *Landolphia* latex is treated similarly in Congo ; *Ficus* latex in Assam, *Castilloa* in Central America, and *Hancornia* at Bahia. The coaguluted rubber comes to the surface. It is skimmed off and kneaded until it is compact and completely dry. At Bahia it is cut in heavy squares, called " thimbles " and it is under this name it appears on the market. These blocks come from the Ivory Coast under the name of " hard lumps." The rubber which is thus prepared is very inferior ; it always contains moisture and non-coagulated latex ; it is spongy and susceptible to fermentation, besides which it has a repulsive smell. This rubber can be improved by methodical washing, but always remains spongy. This process might be called " spontaneous coagulation," the addition of water not being required to bring about the transformation. In this class also we include separating of the rubber by centrifugal force with the aid of a machine, a process little tried, but which seems to suit *Hevea* latex. The coagulation can be accelerated by the addition of an acid. It is then a combination of the mechanical and chemical process.

We shall now examine the coagulation processes based on the use of heat.

There is, first, heating by contact with the ground, which is really a spontaneous coagulation similar to that produced in an open or badly-closed vessel. Here the liquid which comes from the coagulation soaks

into the ground, which acts as a kind of filter. This process is still in use in Western and Eastern Africa. In certain African regions the native catches the latex in the palm of his hand and spreads it over his body. When it has "dried on," they peel it off, cut it in pieces and wind these up in balls. Sometimes they get it in thick cords, which they harden by rolling them in their hands or over their bodies. Certain Congo tribes, and especially Angola ones, operate in this way. Besides the spontaneous evaporation of the latex on the human body, the action of the abundant perspiration must be taken into account. The action of saliva may be considered in connection with that of perspiration. We have been allowed to see natives in the Sudan coagulate the latex of the *Gohine* vine with their saliva. They sucked the liquid by sticking their lips on the fresh incision, and after a few seconds chewing, produced coagulated rubber.

Here also may be included evaporation, as applied in the preparation of the so-called "Ceara scraps" obtained from the latex of the *Manihot Glaziovii*. The very thick latex flows very slowly on banana leaves placed on the ground. The Ceara prepared in this way retains a large quantity of vegetable and mineral matter, which greatly reduce its value.

We shall finish this study on coagulation methods by a glance at those in which *artificial heat* is used. First of all comes the action of *dry heat* and *smoke*. This method has been set forth many times with full details, and, therefore, need not be described here. It is used especially in Amazonais for coagulating *Hevea* latex in the preparation of Para rubber; but it is also used in other parts of Brazil, and even in Venezuela and Guiana. The reasons why this process is in favour are the following: The latex being coagulated little by little, in successive layers, the water is completely eliminated and foreign matter cannot become mixed with the rubber. On the other hand, the creosote, or other antiseptic substances produced by the combustion of palm-nuts, no doubt cause a powerful antiseptic action on the fermentable albuminoids contained in the latex.

Here also may be mentioned coagulation by damp heat or by boiling. M. Von Stein, late manager of the Sanga Nyoko, adding the experience of the natives to his own, advises to dilute the latex with one-third its volume of cold water and to heat it over a fire till it boils.

In British India the boiling method is also in use for coagulating the *Ficus Elastica* latex; the rubber called "Assam" is obtained in this way.

M. Chevalier has proposed the following method, which he has taught the Ivory Coast natives to use for coagulating *Funtumia* latex: Clean water is poured into a boiler (which should be capacious) until it is two-thirds full. It is then brought to boiling. As soon as large bubbles begin to rise, a small quantity of latex, filtered through a piece of linen, is slowly poured in the centre of the boiler. The liquid is stirred with two wooden paddles, upon which the rubber settles little by little, the clot being finally removed sticking to the paddle. When the boiling becomes too intense, M. Chevalier advises adding a little cold water or some latex. The same boiler of water serves to coagulate a very large quantity of rubber if the latex is only poured in as the coagulum gets taken out. The operation ends by taking out the coagulum and flattening it out while still warm on a board to make it into pancakes or slabs. These are then washed and dried carefully.

Criticisms on the Different Methods of Coagulation.

Tackiness.—We have given in detail the preparation of the African rubbers because our experience has been mainly with these, but we

have also mentioned the methods used in the different districts. From this examination we may conclude that two species of method give a good quality product.

First comes the action of heat and smoke, which seems to apply efficaciously only to *Hevea* latex, and is used in the preparation of Para, which up till now constitutes the standard rubber from a scientific point of view as well as from an industrial one.

In the second class we are putting the methods of coagulation by chemical agents, completed by a series of manipulations for the purpose of obtaining rubber exempt from impurities and capable of keeping its nervosity.

All the other methods, even the coagulation by chemical agents poorly done, produce rubber which carries in itself several damaging agencies. First of all comes tackiness or stickiness. The commercial meaning of this word is that raw rubbers so affected tend to turn into a more or less viscous mass, according to the surrounding temperature. In this state rubber sticks to the fingers and is said to be "tacky" or sticky. This is a cause of great annoyance to the harvester, the trader, the importer or warehousers, and the manufacturer. It means loss to all. It is a disadvantage in the factory because the tackiness cannot be eliminated by washing.

The causes of tackiness are hardly known, but we know the conditions under which it develops. Dampness and sunlight favour this disease very decidedly, as shown by the following experiment we made in Sudan. A ball of "Nigger" was cut in several pieces. Some were dampened and placed on the ground exposed to the light of the sun. Others also dampened were put in a bag, such as is used for transportation. This bag was then exposed to the sun alongside the other pieces. After very few hours the rubber contained in the sack had not undergone any change, while the pieces exposed damp on the ground had become partially tacky.

We have also proved on other occasions that badly-prepared rubber, containing latex-serum, coagulation water, soil, etc., was predisposed to become tacky, and we have advocated careful washing and drying in the shade as being favourable conditions in the preparation of good quality and well-keeping rubber. But we must add that good washing cannot always correct bad coagulation. Therefore, we have proposed the coagulation of the *Gohine* vine latex in vessels, by chemical or botanical coagulants of proved value. For the same reason that we have always distrusted coagulation by boiling. We are not sure that the operator will put enough water in to keep the latex from undergoing partial decomposition on the sides of the vessel. Only the last described method, indicated by M. Chevalier, with regard to *Funtumia* latex gathered on the Ivory Coast, represents an advance over the preceding ones. We shall show later wherein its superiority consists. But it seems to us that it can only give good results when used by skilful and conscientious natives.

Conclusions:

To sum up, the purpose of the preparation of the raw rubber is to form a material answering certain physical conditions. The discussions which took place at the London International Exhibition show that we are not yet decided as to the qualities we must demand in raw rubber, that is, we do not agree as to the chemical and physical tests the material must undergo. We do not yet see properly the connection between the figures given by the chemist and the qualities the manufacturer requires.

This is due to our neglecting to apply physical methods to a substance whose conditions of transformation we do not know, to a material which is never found exactly the same twice. We have in commerce certain materials, such as steel, whose every physical and chemical reaction we know perfectly; but this is the result of considerable labour either in the laboratory or in the factory. We have not come to that yet with the rubber.

Still there are certain points we agree upon: Good rubber ought to contain but little resin, no water, and ought to have a certain nerve. Most of the methods of preparation do not seem to tend towards fulfilling these conditions.

In all industrial rubber works this material is now submitted to an energetic compression between cylinders to reduce it to thin flakes.

This ulterior compression of rubber already coagulated in more or less compact masses eliminates a good many impurities. It facilitates washing and drying and gives a rubber which keeps well. But it still allows the presence of resin in the gum. Finally, it does not add any to the nerve of the rubber.

Now we possess in our laboratory samples of spontaneously or artificially coagulated rubber in sealed tubes. The coagulum remains white in the midst of the clear serum. It has been there intact for five years. If taken out it only acquires its elasticity when manipulated in the air. We have often noticed that, when coagulating latex in native calabashes with proper solutions, the coagulum only became elastic after leaving the coagulating liquid, and one could knead it while in this liquid, and give it the shape it was to keep afterwards.

That is why we advise to pour filtered latex in a solution of good coagulant largely in excess. No matter whether the coagulant be acetic, citric, oxalic acid, or a decoction of *da*, the method must be the same. As soon at the latex drops in a thin stream into the coagulating liquid, the rubber separates in white threads while the impurities going with it dissolve themselves in the large excess of liquid. If you invert the method, that is if you pour the coagulating solution in the latex, the coagulum retains in its cavities the impurities of the latex and some of the coagulating liquid. The compressions and washings afterwards are not sufficient to eliminate them completely. This explains why M. Chevalier arrived at fairly good results in coagulating *Funtumia* latex by ebullition, pouring it in a very large quantity of water. We think this water should be changed often, especially when it becomes milky, if good rubber is to be prepared.

Finally, we insist that the coagulum must be compressed *in the vessel itself in which it is made*, and that shortly after its formation. This will not preclude calendering after and washing in plenty of pure water. That is why we criticise the process of preparation in the Straits, which consists in pouring diluted acetic acid in the latex, in gathering the mass of coagulum formed, and in submitting it after to the action of the tearing-up cylinders. In our opinion, a much better quality rubber would be obtained by pouring filtered latex in a proper solution of acetic acid, and flattening out the coagulum in the midst of this solution. This leaf would then be washed in plenty of water before being dried.

Those are the modifications which we think should be brought about in the preparation of raw rubber. We have here only sketched this question on its broad lines; later on we shall return to it again with fuller details.

Rubber Plantations in French Cochin China.

BY ANDRÉ CREMAZY.

President of the Board of Agriculture of Cochin China.
Delegate of the Government of Cochin China.

This lecture was delivered in the evening, illustrated by very interesting lantern slides showing the growth of trees of different ages and the methods used in handling and transporting latex and rubber.

The CHAIRMAN, Dr. Torrey, introduced the speaker in English, after which M. Perrot made a few introductory remarks in French.

In my remarks concerning rubber in Cochin China, I shall leave untouched the technical problems of rubber tree planting, such as tapping, preparation of the latex, etc. Others, more competent and of greater authority than myself, will discuss these matters. I only wish to speak to you of the agricultural resources of this rich country, French Cochin China; and to tell you what has been done up till now in the way of rubber cultivation; what remains to be done, and what may still be easily done there.

This country, which has belonged to France for over 40 years, is known in the European markets particularly for its rice, of which it has exported as high as eleven hundred thousand tons in a year. Its other resources are, unfortunately, very little known as yet; many people are still ignorant of the fact that *Hevea Brasiliensis* grows beautifully there, and that the rubber which has there been manufactured has been sold in France at the maximum price of good Para. But alas! whatever has been planted and harvested up to the present time has been done in infinitesimal quantity. We have no such vast stretches of rubber tree plantations as are found in the Malay Peninsula; we do not export thousands and thousands of tons of this valuable product as does Singapore for the English and American markets; we are only beginners—but, if our plantations continue to develop as they have done for the last two years, we hope to show more satisfactory results. During that period we have planted something like fifteen hundred thousand trees. We have long been wrapped in the slumber of mono-cultivation, which, to be sure, pays us well; we have not looked for new enterprises, and we would still be cultivating rice alone had it not been for M. Bellan, a colonist, who obtained magnificent results with a small plantation of 15,000 trees. The 100,000 francs profit this first Cochin China rubber planter made on his second annual harvest inspired many others. We then awoke to the hope that we should all become millionaires through planting *Hevea Brasiliensis*.

The Government of Cochin China has also been alive to the dangerous effects of mono-cultivation on the general interests of the country,

although the profits were large, and has encouraged the cultivation of rubber trees by regulations which are extremely advantageous to the planters.

Certain countries of Indo-China, of which Cochin China is only a part (the Laos country, for example), produce rubber vines. The rubber is gathered and prepared in a crude way by the natives and sold to Europeans living in the centres. Annam and Tonkin also have rubber vines in their forests, but not so many. Cochin China has none at all.

Hevea Brasiliensis has acclimatized remarkably well. The local government was the first to try cultivating this species in the experimental garden of Oug-Yem (Province of Ehudaumot), fifty kilometres from Saigon. You can see samples of rubber coming from this plantation in the Cochin China exhibit. The trees develop beautifully and attain in five years the necessary girth for tapping, *i.e.*, 50 centimetres one metre above the ground. The colonist whom I mentioned, and who was so successful in his undertaking, followed the example set by the local government. A company was formed in 1907 on the Saigon Phantiet railway line (a branch of the Trans-Indo Chinese line) for the cultivating *Hevea Brasiliensis.* The trees grew with the same regularity as at Singapore, and this company, known as the Société Agricole de Suzannah, possessed at the end of 1910 200,000 trees. They should plant another 200,000—half of them during the present year. The Société des Plantations des Hevea de Xatrach was formed in 1908 in the Province of Ehudaumot, and had, at the close of 1910, 200,000 *Heveas* in the ground, all coming on splendidly. In 1909, stimulated by M. Bellans' very profitable harvest, many colonists were induced to plant *Hevea* trees, and there have resulted large plantations of 200,000 or more trees like that of M. Paris (member for Cochin China) and M. Guery. There are also smaller plantations, some colonists being satisfied with some ten thousand trees. Even the Annamites have followed the example of the Europeans—all of which goes to show, gentlemen, that *Hevea Brasiliensis* has found a home in Cochin China. It is even known to grow in Annam, in the districts near the sea, as far as Apie Uhon, which is as far as it can possibly go.

In certain quarters it had been maintained that *Hevea Brasiliensis* was not going to do well in Cochin China ; they told us that we had a dry season for six months, which was going to hurt our trees, while at Singapore it rained all the year round. It is perfectly true that Cochin China has a dry season for about six months, but on the other hand more rain falls during those six months than falls in Singapore in a whole year. Certain soils, like the "red soils," retain from these rains a moisture which lasts through the dry period. On the other hand, the dry season serves to prevent the development of fungoid growths, which are so detrimental to the trees in the countries where it is always damp. There is no disease of *Hevea* known in Cochin China, gentlemen; none of our 15 hundred thousand trees are ailing !

This must not lead you to believe that *Hevea Brasiliensis* grows in all the soils of Cochin China. There are lowlying portions where the rich rice fields are found (indicated by being marked in white on the map before you) ; there are lands a little higher up where rice grows, but not so well. These tracts are used, during the dry season, to grow corn and tobacco. Finally, there is land which is not inundated during the rainy season ; it is coloured grey and red on the map. That is where *Hevea Brasiliensis* grows. The trees planted in the grey portions look well. They have been manured, and the trees have a normal and promising development.

In the red portions where the largest plantations are found the trees have reached in five years the required circumference for tapping, *i.e.*, 50 centimetres one meter above the ground, and that without any manure. When I say 5 years I include the time spent by the tree in the nursery. It seems to be admitted now by a great number of planters in Cochin China that while *Hevea Brasiliensis* grows well in the grey regions, the red regions are better suited for it. Let us see, gentlemen, with the aid of this official analysis what physical and chemical characteristics of this red soil are.

REPUBLIC OF FRANCE.

GOVERNMENT OF COCHIN CHINA.

LABORATORY OF CHEMISTRY.

BULLETIN OF ANALYSIS No. 604.

I. Sample of soil addressed by Mr. Cremazy, counsel for defendants at Saigon.

Composition. Per 1,000 parts of natural soil dried at 100° Centigrade (212° Fahrenheit.)		Remarks.
PHYSICAL ANALYSIS.		
Ferruginous gravel	7·15	Plantation of Dau-Me CantonMoid'au-Vien Province of Bienhoa.
Sand	78·40	
Clay	438·19	
Carbonate of Lime	6·16	
Organic matter	67·72	
Humus	2·3	Neat red soil, very rich in phosphoric acid, rich in nitrogen and magnesia, tolerably rich in potash and lime.
CHEMICAL ANALYSIS.		
Nitrogen	1·81	
Phosphoric Acid	6·70	
Potash	1·02	
Lime	3·44	
Magnesia	2·49	

Visa : Saigon, 12th August, 1910.
THE MANAGER. The Principal Analytic Chemist of the Laboratory.
Signed : Morange. Signed : P. BUSSY.

All the analysis of red soils have given the same result, with slight variations in the lime and potash ; they are very rich in phosphoric acid, in nitrogen and magnesia, and tolerably rich in lime and potash.

You may be interested, gentlemen, to know how *Hevea Brasiliensis* is planted in Cochin China, and how the labour problem is met.

The nursery plants, grown from seed obtained either from Singapore or nearer home (from the Bellan plantation or the Government plantation at Ong Yem) are set out from the end of August till January. The soil is prepared in October, November, December, January, February and March by breaking up the forests, burning the grass and ploughing. In

April and May holes are made varying in diameter and depth according to the planters' ideas; they are generally 80 centimetres in diameter, and 80 centimetres deep. Planting begins towards the end of May, that is, at the time of the first rains, which are heavier in July, decrease in September and cease at the end of October. It is generally admitted that planting after September 15th is not advisable, for the tree would suffer from the cessation of rain towards the end of October.

As for the mode of planting, the Singapore methods have been followed, for no better guides could be found than the planters of the Malay Peninsula; the teachings of Mr. Ridley, the well-known manager of the Botanical Garden of Singapore, and a man of undisputed knowledge, have greatly assisted us. We started planting in "diamond" shape at distances of 4½ m. by 5 m. as they did at first at Singapore; but they have changed their system in the Malay Peninsula and are planting now at 6 by 7 metres.

We have followed their example in Cochin China. The trees are topped when they are 18 months to 2 years old; certain colonists no longer do this, the practice having been criticised, especially where the trees are planted in close rows. The ground is mowed three times a year at least and ploughed in the places where the "trank" (known as "lalang" in Singapore) grows; to get rid of this deep-rooted and tough grass potato vines are planted in the furrows. The vines spread over the soil and keep the "trank" from coming up again. Some companies, such as the Société Agricole de Suzannah, and the Société Girard et Ascole practice steam ploughing as shown in this photograph. The cost of a six year old plantation may be estimated at from 1,200 to 1,500 frs. (£48 to £60) per hectare (2½ acres) in a red forest soil. In red soils having clearings or small timber growths it is about a third less and in the grey soils where there is little grass and no wood at all the costs are still much less. It has been calculated that the cost of one kilo (about 2 lbs 3 ozs.) of rubber including freight to Europe would be 4 francs (3s. 2d.); M. Bellan has assured me, several times, that his cost of production was below 3 frs. per kilo (1s. 1d. per lb.). The tree when 6 years old yields 150 grs. of rubber (about 5¼ ozs.) 300 grs. when 7 years old, 600 grs. when 8 years old, 800 grs. when 9 years old, and about one kilog when 10 years old. These are the approximate figures given by Ong Yem and M. Bellan.

I desire especially to call your attention to the labour question, which is a very trying one for planters in every colony. To the question which has often been put to me: "Is labour easily obtainable in Cochin China?" I answer yes—but this yes needs some qualification. If your plantation lies near populous centres or in easy communication therewith by railway, for example, you will find plenty of labourers, but they do not like to feel any restraint on them; they like to come to you of their own will. If you are situated as described above, the men will offer themselves to you; they will stay from 15 to 20 days on your property, and will leave for a week to go back to their villages. The Annamite is attached to his native soil, he wants to be at home sometimes; he has to feast his ancestors several times a year because he worships his dead; but he will come back to the plantation and will do good work there. These leave-takings do not interfere with the working of the plantation, for you hire a larger number of workers than you really require. The Saigon to Khanh-Hoa railway line makes it possible for the labourer to come and go every day. This line of communication is of great service; half-wild tribes dwelling on the boundary between Cochin

China and Annam come down from the hills to work on the rubber plantations. We have convinced them to understand that it is more advantageous for them to do piece-work; some of them even become jobbers. As soon as the Trans-Indo Chinese line reaches the Bin-Dinh district (an over-populated province of Annam) we shall find in this vast reserve of men all the hands we need. As to the planters who are not near the centres nor the railway lines they are obliged to hire their help in Tonkin, a densely populated country in the "Delta."

A male hand gets from 0·35 to 0·40 of a piastre and 800 grammes of rice (worth 0·07 of a piastre) per day; this is equivalent to about 1 fr. to 1·30 fr. (10 to 13 pence). A woman's wages are 0·01 of a piastre less than a man's.

It can be stated that there has been no shortage of labour on the rubber plantations in Cochin China. The planters in grey soil who are near the large centres have had all they wanted. But a great deal depends on the plantation manager. If he is not brutal to his labourers, pays them regularly, and houses them in decent huts, his reputation will soon be made and the coolies will stream in.

I mentioned to you piecework just now; this is becoming more general on all the plantations and gives excellent results. You find "jobbers" (or contractors in agricultural work) and these jobbers even have sub-contractors, who buy them the whole or part of their contracts.

I told you, at the beginning of my remarks, that the Government of Cochin China had made regulations which were very favourable to the planters, hoping thus to develop the cultivation of *Hevea Brasiliensis*. Everyone who buys either by auction or by private treaty, or who obtains by grant red land, pays taxes the seventh year only on the land he has cultivated. He has to bring under cultivation within ten years half the land he has either bought or received by grant, the only penalty for defaulting being the forfeiture of the land he has not cultivated after the ten years. The cost of these red lands varies from 0·03 of a piastre to one piastre per hectare (from 7½d. to 2s. per 2½ acres). Any foreigner can buy, and I do not think more liberal conditions can be found anywhere on the globe. If, instead of planting *Hevea Brasiliensis* you wish to cultivate tobacco, manioc, or sugar-cane, the Government gives you authority to do so under the same conditions after having referred the request to the Privy Council. These soils, as you have seen by the analysis submitted, are well suited to the cultivation of these different crops. Gentlemen, there are 400 thousand hectares (one million acres) of red land, only ten thousand (25,000 acres) of which have been sold or granted; so you see, there is still plenty of opportunity in this magnificent country which has a climate as salubrious as that of the Straits Settlements, Java or Sumatra; and is being continually improved by the construction of roads and railway lines.

All that is lacking is European capital—and why it is not forthcoming I cannot explain. The natives have money, but stick to their old ways. They only know how to cultivate rice and how to get money advanced on the prospective crop; they invest practically no money in European plantations or in agricultural undertakings.

These, then, gentlemen, are the facts which I desired to state on behalf of Cochin China, a country that is very insufficiently known. I thank you for the kindness with which you have listened to me.

Being the first French delegate to speak, you will also allow me to express our gratitude to the President, Sir Henry Blake, for his

courtesy; we also have to thank the general manager, Mr. Staines Manders, who has so brilliantly and in such a practical way arranged this beautiful Exhibition, and I do so most sincerely as much in the name of the Government as of my colleagues.

The CHAIRMAN: I am sure we have all enjoyed this paper very much and extend our warm thanks to the lecturer for it. He speaks of it being unknown to Frenchmen. I do not think anyone could have been more densely ignorant of it than I was. I had no idea rubber was produced in Cochin China, and I think the manner in which M. Cremazy has put before us the remarkable resources of the country is worthy of our warmest thanks. It is evidently a country open to enterprise to a remarkable degree, and I think the point about the climate is a very strong one indeed. We have already heard to-day in one lecture about the effects of long dry seasons free from rainfall upon fungoid growths, and therefore the lecturer's remarks on this point are particularly impressive. I assure you that the question of the diseases of rubber trees, due to fungoid growths is one of the very great questions of the day, and a very serious one; accordingly we must agree that the climatic conditions here, if the statements are based upon actual observations, are very remarkable. (Applause.)

A question was asked as to the number of months in which there was little rainfall.

M. CREMAZY: The six months up to the end of October is the rainy season, and during the remaining six months there is little rain.

Rubber Trees and Wild Rubber Reserves of the Amazon.

By J. HUBER, Ph.D.

Director of the Museu Goeldi, Para.

At the first sight it seems perhaps inopportune to speak of the different kinds of wild rubber trees of the Amazon, now that the attention of the rubber world is directed almost exclusively upon the one species, *Hevea Brasiliensis*, and its cultivation. I think, however, that not only the rubber merchant and manufacturer will be glad to know something more about the region which yields the best kind of wild rubber, but even for the planters it will perhaps be interesting to get some new information about the country where the best known rubber tree is growing spontaneously, together with other kinds of rubber trees, some of which, although nearly related with it, yield rubber of a very different value. If we consider that in other countries almost every year some new detected rubber tree or plant, of sometimes very inferior quality, is recompensed and explored with expenditure of considerable sums of money, it seems not idle to call the attention to those rubber trees of the Amazon which although yielding second-class rubber, represent, nevertheless, most valuable reserves of wild rubber.

To begin with the genus *Hevea*, we can, from the point of view of the rubber production, distinguish some well-defined groups of species which, although in the first line of practical value, correspond, nevertheless, at some degree to the principal botanical subdivisions of the genus.

As is already known, by far the greatest part of the Para rubber comes from *Hevea Brasiliensis*, which is not only the best, but also the best known rubber tree of the world, so that it is quite unnecessary to give any description of it. Its geographical range extends through the southern part of the whole Amazonian basin, where it occupies not only the low alluvial lands of most of the affluents of the Amazon, but—as it seems—also some higher lands, principally between the river Tapajoz and Madeira, and also between the higher course of this river and the upper river Purus and its tributaries, the Acre and others. It is, however, possible that these trees of the high land are of another near related but distinct kind of *Hevea*. Mr. Ernesto Ule, who is actually visiting the Acre for the study of the rubber trees of this district, wrote me some months ago that he was inclined to the opinion that there are sufficient differences to separate the species of the main land (terra firma) of the Rio Acre as a distinct one. As to the kind growing on the higher lands between Tapajoz and Madeira, I never received any botanical specimens of it, but the seringueiros of that region assert that it is distinct from *Hevea Brasiliensis*, that it yields a weaker rubber, and that only about the rapids of the river Tapajoz the true *Hevea Brasiliensis*

is growing indistinctly on the flooded islands of the river and on the mainland. That is interesting, because it was from the mainland between the lower Tapajoz and Madeira that Mr. Wickham brought the seed from which the eastern plantations were started. It seems, however, that the trees from which Mr. Wickham collected the seeds were of the true *Hevea Brasiliensis*, and not of the species which gives the weak rubber of the lower Tapajoz (probably *Hevea Collina*). At least, that seems to me the only possible conclusion from all what is known about the botanical characters of the *Hevea* cultivated in the eastern plantations. The contradiction between the assertions of the indigenous seringueiros and Mr. Wickham is easily explained by the fact that the district where the latter collected the seeds (some miles above Boim and two days of travelling towards the west) lies practically on the limit between the areas of the mainland *H. Brasiliensis* and the *H. Collina*, and contains probably the two species. But here lies, perhaps, the reason why the seeds from the Tapajoz are not of the best kind. I just point out that possibility without entering the discussion of this problem, which seems to me too complicated to be resolved without further and very thorough researches on the spot.

If we put aside the debated question of the presence of *H. Brasiliensis* on the tablelands, we can distinguish the following regions where this species is especially abundant.

1. The tide-flooded islands and the shore of the mouth of the Amazon, the so-called island region, from where comes the greatest output of rubber of the State of Pará. In that region, which extends also, with the same hydrographical features, along the affluents of the Pará estuary and the northern mouth of the Amazon, the trees are growing generally on the limit of the regular floods, the distribution of the seeds being effectuated by the tidal currents. Even in that region, where the tapping has begun more than a hundred years ago, and where since the middle of the last century the exploitation is very active, there can be seen very tall trees more than 100 feet high and with a diameter of 3 feet or more. To that region belong also the lower courses of the rivers Tocantins and Xingu.

2. The middle course of the rivers Xingu and Tapajoz, above the first rapids, with their converging affluents. That region, which belongs for its northern part to the State of Pará, in its southern part to the State of Matto Grosso, is only explored for a very small portion and contains immense reserves of *Hevea Brasiliensis*, which for their full exploitation await only better ways of communications.

3. The Brazilian part of the basin of the river Madeira and its affluents, principally those coming from the east and flowing in a north-western direction through the tableland of northern Matto Grosso. The southern part of this region has been explored only in the last years by a federal exploring party under Colonel Rondon, and is said to be as rich in *Hevea* as the celebrated Acre Territorium.

4. The Acre Territorium, which belongs to Brazil, together with the upper basin of the Rio Madeira, which belongs to Bolivia. This is one of the richest rubber countries of the world. Although far in the interior of the Continent and of difficult access, these regions have been rapidly populated by the rubber gatherers and there is perhaps no river where these have not penetrated. It is, however, presumed that with the conclusion of the construction of the Madeira Mamoré Railway the output of rubber from this part of South America will greatly increase.

5. The valleys of the rivers Purus, Yuruà, Yutahy, Yavary and others of less importance, and the lower valley of the Uoayali. Along

these rivers *Hevea Brasiliensis* grows exclusively on the alluvial bottom of the valleys. As these rivers are of easy access to the river craft, at least during the rainy season, they are well explored, Purus and Yuruá being the principal rubber yielders of the State of Amazonas, together with the Madeira.

What *Hevea Brasiliensis* is for the main river and its southern affluents, is *H. Benthamiana*, and the nearest related species for the northern affluents. In a general way, these species are not so tall trees as *H. Brasiliensis*, and their relatively broad leaflets are recovered on the under side with red-brown hairs, principally in the first period of their existence. *Hevea Benthamiana* was first discovered on the river Uaupés, but it seems to be common on the whole superior course of the rio Negro, above the mouth of the Rio Branco, and also on some of its affluents and other neighbour rivers. A nearly related species, *H. Duckei*, grows on the river Yapurá, where it is considered as the best kind of rubber tree. On the river Mapuera, affluent of the Trombetas, grows also a first quality rubber tree which is very nearly related, if not identical, with *H. Benthamiana*. Smoked rubber of these species is said to be nearly equal to that of *H. Brasiliensis*. It is very difficult to get any exact idea of the existing reserves of this first-class rubber, because on the Rio Negro many different species of *Hevea* grow together and seems to be indistinctly tapped, but I have been informed that in the region of the Casiquiare *H. Benthamiana* is very common and can be considered as the principal source of rubber. It is characteristic that the rubber gatherers confound this species with *H. Brasiliensis* or consider it as a simple variety of it.

The second group of *Hevea*, considering the quality of rubber, is composed of the species of *Euhevea*, *H. Guyanensis*, *H. Collina* and *H. Nigra*, together with *H. Cuneata*, *H. Lutea* and *H. Paludosa*, which are of the *Luteæ* group. All these species are easily recognizable by their erected leaflets and produce a second-class rubber, which is generally smoked in the same way as that of *H. Brasiliensis*, being classified under the term of "borracha fraca," or weak rubber.

The most important species of this group are the following :—

Hevea Guyanensis, the type species of the genus, which was first described by Aublet from French Guiana, is growing principally along the rivulets in the high forest and is found in the northern part of the State of Pará (Brazilian Guyana) and in the whole coast region until the river Gurupy. At present it is explored principally between the lower courses of the rivers Yamundá and Trombetas and on the river Gurupy.

Hevea Collina has been found on the Serra de Parintius, and is probably the species which produces the weak rubber of the lower Tapajoz.

Hevea Cuneata (*H. Peruviana Lechl.*) was found on the Ucayali and Huallaga. It yields part of the weak rubber of the Ucayali.

Hevea Lutea, of the Uaupés, is said by Spruce to yield good rubber.

All these species are high trees of the terra firma. As they generally do not grow together in the same localities with *H. Brasiliensis* (only *H. Guyanensis* is found together with *H. Brasiliensis* on the islands westwards of Marajo), their latex is not mixed with that of this species, and as the trees are generally very scattered they rarely are explored. Their product is of a deeper yellowish or brown colour and is distinctly less elastic than that of *H. Brasiliensis*. The seringueiros call these species "seringa vermelha," sometimes also "seringa rana," or "seringa mangue" (*Hevea Guyanensis*), or "Itauba" (*Hevea Collina*).

The third well-defined group of *Hevea* is that of *H. Spruceana* and its relatives, which I have grouped under the name of the *Obtusifloræ*. Some of these species, chiefly *H. Spruceana* and *H. Discolor*, are designed by the seringueiros under the name of " seringneira barriguda," because of their swollen stem. They are poor latex yielders and their rubber is weak and sticky. The Amazonian species of that group are *H. Spruceana*, *H. Discolor*, *H. Similis*, and *H. Viridis*. The State of Pará possesses only the *H. Spruceana*, which has a large distribution over the central part of the Amazonian basin. *H. Discolor* and *H. Similis*, which are difficult to separate botanically, from *H. Spruceana*, are more localized about the mouth of the Rio Negro, and *H. Viridis* grows on the lower Ucayali and also on the Putumayo. The seeds of these species, as far as they are known, are more elongated than those of *H. Brasiliensis* and of a more or less prismatic form.

There are some particular kinds of *Hevea* on the Rio Negro whose latex is said to produce good rubber, as for instance *H. Rigidifolia*, with very rigid leaves, and *H. Minor* and *Microphylla*, with small leaves and pointed capsules ; but on the whole, very few is known about the rubber-yielding qualities of those trees.

Near related to *Hevea* is the genus *Micrandra*, whose species are easily distinguished from the *Heveas* through their single (not trifoliate) leaves and their smaller capsule and seeds. In a general way the species of *Micrandra*, which grow principally in the western part of the Amazonian region, are not well-known as to their rubber-yielding qualities. Only the *Micrandra Siphonoides*, a large tree of the Rio Negro, which is commonly called " Arara seringa," has been studied in the last time by Ule. According to this authority it yields a good rubber, but is rarely explored because its latex cannot be mixed with that of the different kinds of *Hevea* which grow together with it. Rubber is also produced from *Micrandra* on the Putumayo and on the Ucayali.

Of all the Amazonian species of *Sapium*—and there are at least a dozen—only *Sapium Taburu* has until now been recognized as producing a really good rubber. This tree, which is commonly called " Tapuru " on the higher Amazon and " Murupita " in the State of Para, grows on the alluvial lands along the main river and its affluents, together with many other species of the same genus, which, however, produce very inferior rubber or only a kind of glue which turns brittly after dessication. The *Tapuru* or *Murupita* trees form an important rubber reserve, as they are very common in certain parts along the main river and the lower course of the affluents where *H. Brasiliensis* is rather scarce or does not grow altogether, as, for instance, on the lower Amazon, near Obidos, and in other similar places. They spread freely in cleared land and are of very rapid growth. Generally the latex is mixed with that of *H. Brasiliensis*, but in the districts where this species does not grow spontaneously as, for instance, near Obidos, it is sometimes the only rubber tree, and then its rubber is produced exclusively in the form of balls of twisted threads which are obtained by tapping the tree and collecting the scrap in form of strings. As the *Tapuru* is, however, very sensible to the rough tapping method in use, the machadinho producing bad wounds which do not close themselves with the same rapidity as those of *Hevea*, the exploitation of this tree is not very popular, in spite of its frequence and the great facility with which it reproduces itself. It is very probable that the introduction of a proper adjustable tapping knife would greatly facilitate the exploitation of this tree. The inferior quality of the rubber would be somewhat

counterbalanced by the facilities of its exploitation, because it grows on the lower course of the rivers, which are easily reached by the steamers at any season of the year.

The quantities of pure *Tapuru* or *Murupita* rubber exported from Pará and Manaos are still insignificant, and it is impossible to give even an approximate estimation of the quantity of this rubber exported as *Hevea* rubber.

Very important as an actual and future reserve of wild rubber is the caucho tree or *Castilloa Ulei*. This is a large tree of the virgin forest, whose vegetative characters are not very different from those of the *Castilloa Elastica* of Mexico and the Central American species. As it seems there is only this species on the Amazon, with a very large distribution from the Andes to the river Tocantins. On the northern side of the Amazon there are some places on the Rio Negro and in the neighbourhood of Obidos where this tree grows and has been explored during some years, but the principal reserves are on the higher lands between the middle courses of the southern affluents of the Amazon. As these regions are only explored in a very insufficient manner, and as almost every river has proved to be rich in Caucho, the reserves of Caucho will prove to be enormous. That they are very large is proved by the fact that in spite of the destructive exploitation method the output of caucho from the Amazonian region is continually increasing (it has increased from 349 tons in 1895 to nearly 8,000 tons in 1910). Unfortunately, the caucho trees are not tapped in the same manner as *Hevea*, but they are cut down for the extraction of the lutex. This is easy to understand, not only because the tapping and collection of milk is more difficult in that tree, but also because it grows at very distant places, where regular settlements cannot be established yet, the caucheros having the only desire to get away as soon as possible with the greatest quantity of caucho possible. The governments cannot prohibit this sort of exploitation without checking the whole industry, but they should create some large forest reserves in the most accessible caucho districts in the way to prevent the extinction of this very useful tree, whose product, if well prepared, can rivalize with the best *Hevea* rubber. In these forest reservations methodical experiments of replanting and tapping could be conducted for a future regulation of this industry.

The CHAIRMAN : We have just listened to an important paper with reference to the Amazon. I will not take up time by saying anything myself, but will throw the paper open for discussion.

Mr. WICKHAM : Dr. Huber suggested that I should make a few remarks upon the very interesting paper he has read. I must say at the beginning that my experiences are rather old in this respect. Nearly all the *Heveas* that he has mentioned were unknown in my early days ; and from my own experience I should say that the true *Hevea Brasiliensis* has its home in the highlands of Monte Alto, where it is found on the margin. In those parts of the valley of the Orinoko combined with the Amazon, where it is found naturally, it is only trees brought down by flushes in the rainy season and brought up on the lower land. It is only, I think, approaching that great area of South America from the Orinoco side. I did not find any of the true *Hevea Brasiliensis* until passing the cataract, and then only very sparsely until I passed the great tributory of the Orinoco, the Cassiquiare. Then on both sides I found the trees very largely. In the true primitive forests of Monte Alto I found the *Hevea Brasiliensis* very largely, right through all these

tributaries from Atabato up to the source of the Orinoco. The Amazon Valley itself—the plateau in my time—was a great home for it. On the other side, rather lower down the valley, there is a very fine area. And, generally, from my travelling so much there, I came to the very definite conclusion that the true *Hevea Brasiliensis* has its only home in the higher land of the Monte Alto. There is no doubt that many of these other *Heveas* are evidently, from what Dr. Hubert said, coming into commercial use, but in my time they were not much used.

Mr. TERRY: The paper seemed to me to rather strike a parallel with mining, more especially the use of that gold mining expression "reserves." We have heard a great deal about these reserves in South America for as many years as I can remember. It is only a matter of time. It seems to me we have made so little progress in realising these reserves in South America that it would seem a better term to speak of "this unattacked *Hevea.*" It would be interesting to know in how many years this *Hevea* can be put on the market. The output from South America has got up to slight proportions considering the amount that is known to be available.

Dr. ESCH: It was stated a moment ago that there is a large amount of caucho produced in the Amazon Valley—an increasing amount. The chairman of a large rubber works has stated that it is possible to get English cut sheet even with using a certain kind of rubber. This seems to me a matter of great importance.

Dr. SANDMANN: Dr. Huber's very interesting remarks lead me to express my own ideas as to the future of rubber production in the Amazon country. These views are based on observations I made personally when I was in Brazil, and some of those who are present may be interested in them.

The total export quantity of rubber from the Amazon district is made up of two separate products. Unless this fact is recognised the increasing statistical figures will give rise to the erroneous impression that the total production is continually growing; for the published figures combine the *Hevea* rubber (which comes on the market under the name of "borracha") and the *Castilloa* rubber (known in commerce as "caucho") in one total. In the export customs statements, however, these two kinds of rubber are entered separately, and it is seen that the exports of *Hevea* rubber have scarcely increased at all since 1903, but that the exports of *Castilloa* rubber have constantly increased; it is therefore of importance to examine the reasons for this state of affairs in order that we may estimate intelligently the production to be expected in the future.

Hevea rubber is obtained by tapping the tree by means of a small axe, called the *machadinho*. In spite of this rough treatment the trees continue to grow and remain productive for many years—simply because only fairly old trees—of 15 or 20 years old at least—are selected for tapping.

The rubber collectors (*seringueros*) are almost exclusively Brazilians, and mostly come from the states of Ceará and Maranhao.

In consequence of the frequent droughts, they are generally obliged to leave their native states, but are not inclined to go to the states lying to the south and to do the more systematic plantation work. They prefer the free life in the woods of the Amazon, and it is to be expected that these people will continue to go to the Amazon country as long as it is possible for them to find there the means of satisfying their extremely simple living requirements.

The majority of these people earn a mere subsistence. Even when high rubber prices prevail it only means for them some small luxuries in clothing and victuals. Very few ever succeed in saving anything. The number of workers, however, is limited, and in consequence the production is limited, too. When prices are high there is less necessity for exertion on the part of the worker ; when they are low he must work all the harder to make a living. On the other hand, the demand for labour is, of course, keener when prices are high. Thus it comes about that the number of workers remains practically constant—and hence the production of *Hevea* rubber is also about constant.

Not so, however, with caucho. In order to obtain this rubber the trees are cut down, which closes their productive career. The labourers who take to this kind of work (called *cauchoeros*) are mostly Peruvians. Formerly caucho was obtained in Peru alone, but when the trees there were destroyed, the *cauchoeros* went further and further east, until now they have probably advanced to the Rio Madeira.

Rubber production by cutting down the trees certainly involves harder labour than tapping, as in the case of *Hevea*, and it is probably for this reason that the Brazilians do not take to it.

Now, the production of *Hevea* rubber (borracha) is now almost the same as it was in 1903. High prices have not been able to effect an increase in the production—in fact, the annual figures show increases in production when prices have been low, but the production of caucho has increased during the last few years when high prices ruled, the increase for the last 10 years being from a quite insignificant quantity to 8,000 tons.

The probable reason for this increase in production is that at high prices it seems to pay the *cauchoeros* to cut down younger trees, which yield less than 25 kilos. per tree, which is the normal quantity obtained from older trees. However, in consequence of the cutting down of younger trees the quantity of the caucho has become poorer, for it is certain that young *Castilloa* trees as well as young *Hevea* trees yield a poorer quality rubber.

The consequence will be that in future, and especially in times of receding prices, the production will decrease greatly, for not only will old trees be scarce but it will not pay to cut younger trees either.

The *cauchoeros*, however, accustomed as they are to hard work, can easily make their living in other branches; in timber production, for example.

In case of *Hevea* rubber production, however, the conditions are different. There is, as Dr. Huber says, no scarcity of *Hevea* forests in the Amazon district and many large unexploited areas of *Hevea* forests stand waiting as a reserve. The only difficulty is to create means of communication with those districts. Once such communications are established, the transport of the rubber to the markets of the world will be cheaper, and the cost of living will be less for the *seringueros*, and to such a degree that even with much lower rubber prices the production can be maintained. This is a problem the solution of which must be mostly left to the Government.

Even now the Brazilian Government seems to be convinced that such means of communication are necessary, unless they wish to lose in the future their export trade in rubber. The Madeira-Mamoré railway, which has already been opened, is the first effort in this direction, and necessity will soon enforce further steps in the same direction.

But the Government must facilitate the production of rubber, not alone in the way of creating means of communication, but also by lower-

ing in import duty on food and other necessaries of life for the *seringueros*, and also by reducing the export duty on rubber.

There are, moreover, other ways of stimulating rubber production by private enterprise. The greater part of the necessities of life for the *seringueros* could easily be produced in the neighbourhood of the districts where the *seringueros* live, or, at any rate, within the State. The greater part of the food supply which must now be purchased at fancy prices could be produced cheaply near the working districts. That this is possible is borne out by the fact that formerly the Amazon district was an export country for food—especially rice, while at present the production of rice has completely vanished.

To sum up, then, in the future the Amazon district will continue to export caucho, though in smaller quantities, but *Hevea* rubber may be expected in considerable quantities, even with very much lower prices. Of course, though, a time may come when the exports of rubber will be at a low ebb—namely, before the conditions for a cheaper production are created.

Dr. STEVENS: I should like first to refer to a former statement of Dr. Esch that an experiment we undertook did not result in the production of a good quality of cut sheet from plantation rubber.

Dr. ESCH: Formerly it did give a good result, but with a certain Continental firm it did not.

Dr. STEVENS: What kind of rubber was it?

Dr. ESCH: Light crepe.

Dr. STEVENS: There seems to be some mystery about this. I shall have great pleasure in showing Dr. Esch some cut sheet made from plantation crepe by a factory in this country which is very good. Dr. Esch says it is not good now, but previously it was. These samples were about 12 months old, but I believe the factory is still making good cut sheet from plantation rubber. I have not heard, and have no reason to suppose, that they have had any difficulty. The word "caucho" has been frequently used. There seems to be a good deal of misunderstanding as to what is understood by that word. I took the opportunity of asking a gentleman who came from Brazil some six months ago, and he said he did not know. My impression was it referred to *Castilloa* rubber, but apparently on the market it refers to a kind of *Hevea* scrap. I think if Dr. Huber would give us his views on that, and say exactly what "caucho" is, it would help us all, and we should then be talking about the same thing. I was very interested in Dr. Huber's paper, and also in Mr. Wickham's remarks, because we so seldom have an opportunity of hearing these things at first hand, especially about the Amazon. Few of us have been there; most of us go to the East, and our knowledge of the Amazon district is based on what we read in text-books, and text-books are proverbially not to be relied upon. I was particularly interested in two points: firstly, the statement that the species on the highlands and round the mainland on the lower part of the river are probably of different species.

Mr. WICKHAM: Many species.

Dr. STEVENS: And, consequently, Mr. Wickham came to the conclusion that the other species, presumably inferior species, were being tapped to a larger extent than was the case previously. One wants to know what is "fine hard Para"? Is it *Hevea Brasiliensis*, or a mixture

of rubber from *Hevea Braziliensis* with other substances, and is it *Hevea Brasiliensis* that is responsible for the high quality of fine hard Para ?

Dr. PETCH : We are supposed to have had two species of *Hevea* brought into Ceylon at different times, one of them *Hevea Spruceana* and the other *Hevea Brasiliensis*. India refused to have them, and threw them away into Ceylon. Of course, in these days the genus had not been split up to such an extent as it is at present, and the nomenclature which we got then is that of 30 years ago. I have never come across any *Hevea Spruceana* in Ceylon. The report is that it died out ; therefore, all we have now is from Mr. Wickham's seed. We cannot make any definite statement about what our trees really are, because it is the only tree we have, but we hope, with the help of the splendid botanical work done in Brazil at the present time, to settle the question within a very short period. The work, of course, must be done on the spot in Brazil. I cannot help pointing to what the man in the street regards as pure waste of time. Someone goes out into the tropics and collects specimens, they are put in a museum, and everyone who is only interested in making money thinks him a lunatic, but when we want to know what we have, whether *Castilloa* or *Hevea*, the man we go to is that man whose work was despised.

Dr. TROMP DE HAAS : I should like to ask a question. You pointed out, Dr. Huber, that there are several species of *Hevea*, and I remember Dr. Huber has determined 19 species. I notice that he made his determination only on the form of leaf. If you go on an estate in the tropics, Sumatra, Ceylon or Malacca, you find different kinds of leaves and you give the trees different names, but I do not believe that is exact. For instance, in gutta percha trees there are three gutta percha trees. I took them to an expert and asked him to point out what the trees were, but even when he came on the estate he said it was impossible to say. It is a peculiar thing, but when I was in the jungle I could easily name all three. With cultivated trees it is impossible. Possibly by cultivation the habitat is altered. I doubt as to there being 19 species. What is the difference between a species and a variety ? We had some experience with *Hevea Spruceana*. We got a case from Kew and found it contained *Hcvea Spruceana*. I cultivated the tree, and found it differed from the *Hevea Brasiliensis* which we got from Kew, but it is very difficult to know whether we have the real specimen or not.

Mr. WICKHAM : All the *Hevea* in Ceylon came from the first trees ; I got them myself.

Dr. TROMP DE HAAS : They show already differences in their leaves.

Mr. WICKHAM : It appears to me, from practical experience, that there is an infinite leaf variation not only between various trees, but in the same tree. You will find with *Hevea* the young tree produces a large leaf, almost as large as that of a horse chestnut, and as it becomes an old and matured tree, the leaf diminishes in size. In the large trees of Monte Alto you find the leaf very small. This also applies to the seed, which at first is more cylindrical and differently coloured and marked. When I was in South America I could easily distinguish the age of the trees in this way. In the old trees the shell of the seed gets thicker, of darker colour, and more flattened on the one side, with the growth more distinctly marked. The young seed is very much more cylindrical, and larger—more like a birdcage. These variations are only what may be expected from *Hevea*. Look at the coffee in South America, how it has developed leaf variations.

Mr. Terry: A question was raised by Dr. Esch, who said that one year it was possible to get satisfactory cut sheet from plantation rubber, and another year it was unsatisfactory. I was sorry to hear from Dr. Stevens that the Premier Company——

Dr. Stevens: I mentioned no company.

Mr. Terry: We know there are only three companies making cut sheet. Well, this unknown firm have succeeded in producing a satisfactory cut sheet. But it is generally known that plantation rubber does not produce good cut sheet. The main reason is that the rubber is not so good, and if it is good, it is only in certain plantations. The manufacturer cannot buy 30 tons of plantation rubber of the same quality. I have discussed the matter with Ceylon planters, and one very youthful partner told me he was surprised to hear what was said, and that manufacturers must understand that their rubber was the best and could be used for every possible purpose. For myself I do not think much progress has been made. Some manufacturers do not use plantation rubber for that reason. In regard to South American rubber, it is always the same and can always be relied upon. There is no question of scientific experiments and the manufacturer uses no test. There is no longer one quality of plantation rubber. There are two or three qualities of cut sheet. Of course, there are plenty of other purposes for which plantation rubber can be used.

Dr. Esch: With regard to what Mr. Sandmann suggested as to the lower quality of caoutchouc, I may state that the production of English cut sheet from caucho is only possible with very good selected *Castilloa* rubber. You must select the caucho ball before going into the process. I have found that several people are interested to give other kinds of rubber the name of caucho. They classify it as first-class "Caucho" ball. Prima-prima balls are sold in Hamburg, and I found they did not come from the Amazon but were of Peruvian production, and not so good as from the Amazon. Those produced in the Amazon Valley are very large balls, while those which are called prima-prima Peruvian balls are only small sausages, and therefore it may be that not so good a result is obtained. But I may state that if you take a good selected caucho ball, which is considered by most people as most inferior to common plantation rubber, you may get good English cut sheet from it. With regard to obtaining English cut sheet from plantation rubber, I can say that in Germany transparent rubber goods, such as teats for children, form an article of large importance, and German manufacturers have made several endeavours to get English cut sheet from plantation rubber, but did not obtain a good result. You may get cut sheet, but it is a very weak one from plantation rubber. English cut sheet made from caucho ball is also weak. It is not every kind of caucho that gives the good quality of English cut sheet. I only wanted to say that the caucho ball which is commonly recognised as a second quality rubber compared with plantation rubber, is better than plantation rubber only in some cases.

The Chairman: I am sorry, but we shall have to draw the discussion to a close because our time has gone too rapidly and we have other papers to get through. I will ask Dr. Huber to reply.

Dr. Huber: Many important questions have been raised. One of the most important, touched on by Mr. Sandmann and Mr. Terry, was as to when we were to expect a larger output from the wild sources—from the reserves which are principally found in the southern part of the Amazon region. It is certain that there is the principal headquarters

of *Hevea Brasiliensis*, and perhaps we shall have in a few years some important means of reaching that region. The principal difficulty in reaching those districts is because of the rapids of the many rivers. The Madeira Railway has already made great progress, and a portion of it has been open for traffic in the last few months. Then there is a railway projected on the river Tapajos. There is already a road made, and the railway will probably be completed in a few years, but it is impossible to say whether it will be two, four, or ten years, though I think that before ten years is over we shall have the railway. Then there is another way of communication of great importance on the river Zingu. That region has already been penetrated, and a good road has been made cutting the principal rapids of the river Zingu. In this region, also, there is to be made a railway, the project having already been submitted to the Government. On the river Tocantins, which gives the entrance to the principal caoutchouc region, a railway has been constructed in parts, and it will be prolonged to a point from where navigation is possible near this region. You thus see what we are to expect in regard to means of communication in the future exploitation of the reserves of the Caucho and *Hevea* rubber which I have referred to. These ways of communication are making good progress. They are not yet ideal, but they can be prepared in a few years. There is another question which is also of great importance. Mr. Sandmann has said that the principal production of *Hevea* rubber has not augmented of late years. That is true. The question, as Mr. Sandmann has said, is principally one of labour. We have a certain amount of labour, and these labourers, of course, will have to produce more, when prices are low, in order to get their subsistence. It is true that the labourer with his simple subsistence does not need to produce much rubber. If we calculate that three coolies will produce the average of a mán a day, I think, even at a low price, it is sufficient to give them a living.

There remain the botanical questions, and these are very complicated. I will first deal with the question of " Caucho," because it is more simple than the others. In the Amazon it is always rubber from the *Castilloa* tree. In some regions it is already exhausted, principally in the Peruvian part of the Amazon, and the pickers have penetrated into the Brazilian territory and are now working on the three rivers. On these rivers the rubber resources are diminishing. The principal reserves of Caucho are between Madeira and the river Tocantins. On this river there is no Peruvian caucho. These come from the East, from Bahia and Rio Grand do Sul, *i.e.*, they are Brazilian. Attempts have been made to tap the caucho tree in the same way as *Hevea.* It is difficult where the trees are very scattered, and where communications are very difficult, to obtain a regular exploitation, but perhaps in some of these districts it will be possilbe to obtain this exploitation. As to the question of *Hevea* I said in my paper that *Hevea Brasiliensis* is the best *Hevea,* but, of course, I said that *Hevea Brasiliensis* is to the southern part of the Amazon what *Hevea Benthamiana* is to the northern part, because from the northern part—at least from a certain distance from the main river—we have never received specimens of *Hevea Brasiliensis*. There are all other kinds of *Hevea*. Mr. Wickham states that *Hevea* grows on the Rio Negro and its affluents ; this proves only that the species which grows there is considered by rubber growers as equivalent to *Hevea Brasiliensis*, and, of course, it has a similar appearance, and is a similar tree. All these species of *Hevea* are very similar, though there are some which have very distinct characters, while others are difficult to separate.

Dr. Tromp de Haas said that even in the plantations there is a great difference in the form of the leaves and the size of the leaves. I have observed the same thing in spontaneously growing specimens. Rubber gatherers generally distinguish two forms which they regard as equally good, or nearly equally good: the white and the black Seringuea. These are two forms of *Hevea Brasiliensis*. Botanists agree there is no difference in the flower and seed, but there is a difference in the leaves. They call these species white and black because the white has a white bark and the black has a black bark, but it is only a difference of exposure. If we plant *Hevea* on a border we have the white variety because of the white lichen which grows on the bark, but in the interior of the forest the bark is of a dark colour because of the dark lichens growing on it. That is the principal difference. Of course, there will always be a difference in the thickness of the bark and other characteristics. In the size of the leaves and the narrowness of the leaves there are many differences in a plantation, or even in a small district where *Hevea* grows. Some specimens have narrow leaves, while others have broad leaves, and young specimens always have large leaves in comparison with adult specimens. But that does not make any difference in the botanical description. It is true we have great variations in the seeds. I have shown in our stand a collection of seeds of *Hevea Brasiliensis*, and you can see the great variation there is, but there is always a certain combination of characters which are characteristic of the species. Even in cases where there is much variation, we always have in each species a certain combination of characters which is the same. It is necessary to make a thorough study of individual variations to know what is the variation of each species. In all cases there are many species of *Hevea*. With regard to what Mr. Wickham said, as to seeds having been collected in a region where only weak rubber grew, I do not say that in 1876 there was not strong rubber coming from there. I explained this by the fact that the region where Mr. Wickham went in the interior appears to be a district between two places, one of which furnishes an inferior kind and the other the true *Hevea Brasiliensis*. It is possible these have intermixed and that a difference has been caused by hybridising. It is not proved that *Hevea* can hybridise, but it is not impossible. The fact that plantation rubber is a bit inferior to our Amazon rubber may have a botanical cause. I do not say it has a botanical cause, but in all cases it would be interesting to make a thorough examination. I should like to have an opportunity, and I think I may have, of examining personally the trees in the botanical gardens to see if there is any specimen of another kind.

Dr. Tromp de Haas: Do you not tap older trees than we do?

Dr. Huber: Of course, they tap only the old trees, but in the islands exploited 50 years or more ago, they have been forced to tap young trees also, though I do not think that there are any tapped younger than 10 years.

The Chairman: We are much indebted to Dr. Huber for his interesting paper, and I am sorry the discussion cannot be prolonged, because there are many points not finished and a number that have not been taken up.

The Rubber Industry in Peru.

By Mr. EMILIO CASTRE.

Dr. HUBER in the chair.

Peru is commercially and industrially known for the extraction of precious metals: silver, gold, copper, iron, coal, other ores and petroleum; in agriculture for cotton, sugar and alcohols which she exports to Europe, North America and some other parts of America; but with regard to rubber, and the trees which produce same, Peru is not sufficiently recognised as one of the principal countries producing this commodity. It is, however, necessary to point out in this respect, some of her physical conditions having relation to this industry, the nature of the territory, the geographical situation and botanic systematical division of various rubber plants growing in the country which are now well known.

If we take into consideration its geographical position, the source of its rivers and its topographical situation of its forests, then we take it that Peru is the real home of the Rio Mar (Sea River) of the large and rich Amazon, the greatest of the world, and of many rubber plants which have been known and classified up to the present, among which *Hevea Brasiliensis* takes a predominating part.

In fact, there are three principal, large and rich rivers which form the Amazon:

The Huallaga:—Source: Latitude 10° 57′ S. Altitude 4,300 metres till its junction with the Maranon, 5° 5′ 25″ L.S. and 17° 55′ 52″ L.W. Paris, at an altitude of 114 metres above the sea level. This course runs over 1,100 kilometers.

The Maranon:—Source: 10° 20′ S. Altitude 3,900 metres till its junction with the Ucayali, at 4° 30′ L.S., and 75° 47′ 34″ L.W.P. at 110 metres above the sea level. This course runs over 1,650 kilometres.

The Ucayali:—Let us take this one from the union of the rivers Tambo and Urubamba. Altitude 264 until its junction with the Maranon, as indicated above. Approximate course 2,210 kilometres, descending to 114 metres above the sea level. Each of these rivers is navigable for their greater part; they receive an infinite number of tributaries which rise in the white-topped Andes or which filter their way through and rise at some lower level, and all these eventually find an outlet in the basin of the Amazon, or the Eastern part, south of the country, 62 metres above the sea at the part which belongs to Peru.

Within this circuit, which the Andes and their eastern spurs girdle, one comes on to the Pampas del Sacramento, which cover a territory of 30,000 square kilometres. These and other steppes in the north and south of the country more or less equal in longitude, are intersected by rivers, streams and valleys, forming a long net extending over a large surface. This part of the Peruvian territory, which includes the Departments of Loreto, San Martin, in the north, and parts of Junin, Huanuco and Cusco in the centre and south, is over 650,000 square kilometres in extent, or say some 400,000 square miles.

The topography of the territory in this region, which we can well call the rubber region, is both undulating and flat: some dry, some humid, and some marshy lands. The average temperature is from 21 to 22° Centigrade. On the warm summer days the thermometer marks 27° to 30° in the shade. In the evening between 18° and 16°.

There are two seasons, summer and winter; the first from April to December. During these months the rubber is extracted. The second from January to March, during which season the rain falls abundantly and floods the low territories. The rainfall averages from 13 to 14 inches per month.

The climate of this zone is mild, compared with that of other countries which are nearer to the Equator, as corroborated by the following reports:

Sir Clements R. Markham, K.C.B., F.R.S., Secretary to the Royal Geographical Society, etc., etc., the distinguished traveller and scientist, who for many years travelled in Peru, making scientific studies, and who possesses an intimate knowledge of the country, writes to Mr. H. Guillaume, F.R.G.S., Consul-General for Peru, in Southampton:—

"Dear Sir,—I rejoice to hear that you are bringing out a work on the 'Amazon Provinces of Peru,' and I trust that its publication will have the effect of promoting colonisation and spreading a more correct knowledge of the resources of Peru. I consider that the slopes of the Eastern Andes within the Republic of Peru are very suitable for European colonisation and offer an admirable field for industrial enterprise."

On this territory, from the altitude of 1,000 metres, more or less above the level of the sea, many of the *Euphorbiaceas* and other specimens of rubber are found on a smaller scale.

* Huber, on his excursion to the rivers Ucayali and Huallaga, in 1898, crossing the pampas or plains of Sacramento, above mentioned, from east to west, found on his voyage, *as a traveller* and not as an explorer, the following specimens:—

ULMACEAE.

Castilloa: Ulei Warb. (Rubber), Cerro de Canchahuaya Mountain, Rio Ucayali.

HEVEAS.

Hevea Brasiliensis: Arg. River Catalina (Plains of Sacramento).
Hevea Cuneata: Huber (new nomenclature) ditto.
Hevea Viridis: Huber ditto ditto.
Hevea: Aff. *nigra* Ule (Ashes) ditto.
Hevea Lutea: var. Mull. Arg., or *Hevea Peruviana.* Lechler ditto.
Hevea Randeana: Huber (new sort).

SAPIUM.

Sapium Aucuparium: Jacq. (Siringarana).
Sapium: Peeppigu. Hemsley and Hooker ditto
Sapium Bligandulosum: var. Kamatum. Mull. Arg. ditto.
Sapium Marmiari: Huber (Siringarana). ditto.

OTHER SORTS EXISTING IN THE COUNTRY.

Hevea Paludosa: Ule. Iquitos.
Hevea Spruceana: Mull. Arg.
Hevea Guayanensis: Aublet, Linne, Screber.

* Dr. Phil. Jacques Huber, Director do Museu Goeldi, Para, Brasil.

Hevea Cameraria : Latipolia, Pierre.
Hancornia : Specious Mull. Arg.
Last year I found in the Upper Huallaga many trees of :
Sapium Pavoniarium.
Sapium, off Utile.
Micrandia.

The leaves of these latter three trees were recognised in Para (Brasil.) by Huber as being equal to the afore-mentioned sorts. These are the sorts and specimens known and classified up to now. It is understood that if Huber on a mere passage over the Pampa del Sacramento found most of these, a botanical exploitation would certainly have discovered many others which would constitute a new scientific nomenclature on that immense territory, whose surface extends over 747,296 square kilometres, more than that of France, Switzerland, Belgium, Holland and Denmark put together, where unexplored lands and rivers exist, all covered with gigantic and secular timbers, known under the name of Montaña (mountain).

Production and Exploitation.

On the most accessible parts, for about 30 years, the *Castilloa elastica* (caucho) has been exploited, and this tree is unscrupulously destroyed as is, unfortunately, also done in other productive countries ; fortunately the vines remain. Such a noxious system will soon cease in Peru, as energetic measures are being adopted to suppress such practices.

The *Hevea Cuneata*, Hub. or *Hevea Lutea*, var. Mull. Arg., or *Hevea Peruviana*, Lechler, which rubber is known as fine weak rubber, is also tapped, and its exploitation was begun six years ago.

Some *Sapiums* have been tapped a short time ago giving a second-class product, called *Shiringarana*, *Caucho Masha*, or Gutta Percha.

These products are generally sub-divided and defined by the trade as follows :—

Jebe Fino. (Para rubber. Fine Para.)

Hard Para.

Entre fina. (This denomination has been given on account of some impurities adhered during the collection of the latex).

Sernamby de Jebe. (Scraps). (Residues of latex coagulated on the tappings which are gathered from the bark).

Caucho.

Sernambi de Caucho. (Latex coagulated on the trunks, on cut branches and on the soil, with "detritus" or impurities).

Jebe debil. (Weak fine).

Tails. (Rabos del Putumayo). (Mixtures of the latex of the *Hevea Brasiliensis* and weak fine, coagulated as scraps).

Fino Mollendo. (Region of the Madre de Dios in the South).

Caucho Ball.

Peruvian Slab. Dead Caucho.

Production of Rubber in Peru for Eight Years.

	1902. Kg.	1903. Kg.	1904. Kg.	1905. Kg.
Hard Para (Jebe Natural) ..	719,700	176	798,776	763,123
Fine Para (Sernamby Jebe) ..	225,258	——	300,729	330,549
Peruvian Slab (Caucho) ..	89,299	14,886	78,571	101,810
Caucho ball (Sernamby) ..	649,945	2,792	1,042,848	1,343,137
Rubber not specified	16,339	2,089,997	——	——
Total	1,700,541	2,107,851	2,220,924	2,538,619

	1906. Kg.	1907. Kg.	1908. Kg.	1909. Kg.	1910. Kg.
Hard Para (Jebe Natural) ..	854,176	833,259	800,874	978,540	313,694
Fine Para (Sernamby Jebe)	337,723	604,213	378,542	703,112	199,272
Peruvian Slab) ..	88,962	142,223	126,419	133,810	50,387
Caucho ball (Sernamby) ..	1,294,266	1,398,230	1,209,836	986,105	530,745
Rubber not specified ..	——	——	——	——	——
Total ..	2,575,127	3,027,925	2,515,671	2,801,567*	1,094,098†

* The falling off in 1908 is generally attributed to the financial crisis in the United States in 1907, and was universal in the rubber industry.

† For the year 1910 the figures are up to May, and are not to be taken as nalf the product for the year, as the greater portion is exported after July.

Manipulation of the Rubber.

Systems of Extraction and Coagulation of the Latex.

Extraction. The system of extracting the latex from the tree *Hevea Brasiliensis*, *Hevea Cuneata*, and the *Sapium*, is effected in Peru by means of incision; the stripping away of the bark is not known over there.

The incision is made with a "machadino," or small hatchet, as shown in our illustration, making the incision diagonally upwards of a size of about an inch; the edge of the cup is then fixed to receive the latex. This operation is accomplished daily from 6 a.m. to 12 a.m. collecting the sap, which is put in a pail for coagulation.

The *Castilloa* tree (Caucho) is, as before mentioned, hewn down, and gives its latex from the trunk, and is caught by a dish which is placed in a hole of three feet by two made in the soil.

Coagulation. The method of coagulation of the latex obtained from the *Heveas* and *Sapium* is effected by smoking, which system consists in pouring the latex over a round stick which is placed directly over the orifice of a small oven of conical shape, from which issues the vapour and smoke of very hard wood, and of fruit and nuts obtained from several palms which grow near at hand. This produces creosote and acetic acid, which antiseptic substances are absorbed by the intercepted membranes or coverings of the latex. This system, apart from the defects recognised by experts in rubber, like Norzagaray and others, gives to the product, elasticity, resistance and strength; its colour is yellowish or old gold, and the mass takes a globe or pear-shaped form.

The coagulation of the latex of the *Castilloa* (Caucho) is effected by a mixture of ordinary soap, water and of some plants commonly called *Vettilla* (a species of creeper). The product forthcoming is a glutinous and porous mass, containing much water, and when in a decomposing state produces a disagreeable odour, until it has become dry. Its colour is kid black, and is block shaped.

The employment of acetic acid or other chemical substance is not, however, effected in coagulation processes there.

Production.

A labourer taps regularly two "Estradas" daily; each of these contain 100 trees raised in the jungle. The average production of each tree is 2 kilos. (4 lbs. 7 ozs.) of dry rubber, during eight or nine months of the tapping season.

The rubber product is sold in neighbouring places near the place where it is extracted.

The expenditure for the exploitation and manipulation of the product is from 30 per cent. to 35 per cent. of the price the finished article fetches locally.

PREPARATION AND PACKING.

The fine rubber or hard Para and other similar kinds which, as before mentioned, take the form of a globe, pear, flask, etc., during the coagulation process, the medium fine rubber in form of blocks, the scraps of the Putumayo, etc., are packed in closed cases, weighing 130 to 140 or more kilos., nett, embarked at the port of Iquitos (Rio Amazonas) for Liverpool, London, Havre, Hamburg, Bordeaux, and North America, where it is mostly considered a Brazilian product. This mistake is one of the reasons why Peru passes mostly unobserved as a productive country, although our Custom House and Consular statistics show the Peruvian origin of this rubber.

Another point of vital importance in favour of rubber produced in Peru is the fact that, although its quality is in every way identical to that produced in the Basin of the Amazon when that mighty river flows beyond the boundaries of Peru, the export duty imposed by the Peruvian Government is but about a third of that which is bourne by the product emanating from Brazilian territory.

The Future of the Rubber Industry in Peru.

Peru, whatever may be the future vicissitudes of this important industry, will, nevertheless, absolutely maintain its present production of rubber, preserving all plants producing wild rubber, improving the system used here for the extraction of the latex and of coagulation by the application of methods which, above all, insure purity of article and preservation and healthiness of tree, which, as we know, is indigenous to the Peruvian soil, and in order to remain vigorous does not require artificial drainage and consequent outlay.

The bacteria of the soil is not infested with elements which might develop plagues or destructive growths, the position of the trees being practically sheltered by the forests which surround them, protecting them from the heavy winds which so often destroy them elsewhere. Peru will also further develop the existing plantations of *Hevea Brasiliensis* within a recognised and suitable area, using for its cultivation scientific methods and practical applications as used in Ceylon and other countries, and the existing systems are being studied very prodigiously towards this end. Fortunately, nature has endowed it very favourably for the purpose, as it is situated in an ideal position, and the large and fertile territories are formed by just the sort of ground, humus collaborating with rich strata in the formation of alluvion, which scientists and botanists have proved the most efficacious for the purposes of rubber growing. The humus, a rich organic composition containing large quantities of carbon, nitrogen, and potash, so necessary for the nutrition and life of the plants, has accumulated through many centuries. The temperate climate, which is beneficient to all living things, and the necessary rainfalls are, as we know, the essential physical conditions required, not only for the cultivation of the *Heveas* but also for other plants, and may be considered as a guard against the eventualities of the rubber-collecting industry and its universal production, which insures, in any case, a safe return to investors.

These territories are still for the greater part vacant; and the Government grants the freehold to colonists at the rate of two shillings

per hectare (10,000 square metres), or about 2½ English acres. Most of them are fed by large rivers which are navigable in their greater part by steam, and all others are fed by smaller rivers, also navigable by canoes and rafts which are useful as the means of transport. The Peruvian Government has already contracted with a North American company the construction of a railway which, connected at its base with the famous Mines of Cerro de Pasco, will extend to the rivers Huallaga and Ucayali.

Another railway feeding the North is already under survey, starting from Payta, three days' voyage from Panama; it will extend to the Rio Maranon, which would give direct communication between the Pacific and Atlantic and those virgin regions of rubber lands and dependent industries, the existence and development of which have prompted the Committee of the Rubber and Allied Trades' Exhibition in London to give you the benefit of their very able efforts in presenting to your inspection and knowledge the numerous phases of this beautiful and interesting subject.

Peru will always welcome an opportunity to give any further information, and you are cordially invited to their stand, No. 125, which, though very modest in its way through the lateness with which the decision to be represented here was given to its commissioners, is, nevertheless, comprehensive in its purport, and the samples of Peruvian rubber shown there cannot but impress anyone with the unalterable fact that this fine country is henceforth to be reckoned, amongst other things, as a very important rubber-producing region of our Western World.

The CHAIRMAN: I think we are all very much obliged to Dr. Castre for his interesting paper. It gives interesting details on a region which cannot be considered as unknown from the special point of view of rubber production. As he points out, Peruvian rubber has to go through Brazil and is considered generally as a Brazilian product. It is true that there are Peruvian balls which are known as a Peruvian product, but *Hevea* from Peru is not generally distinguished from the hard Para of Brazil. Caoutchouc or Peruvian balls were exported from Peru before they were exported from Brazil. *Castilloa*, which is found on the Amazon, was first found in Peru and exported from there ten years before it was found in Brazil. Dr. Castre has named different trees which are explored for rubber, but, of course, the *Hevea Brasiliensis* must be considered the most important. It was only exported from Peru after *Castilloa* had been exported for several years, and here the contrary is the case to what I first mentioned, the exploration of *Hevea* being exported from Brazil before *Castilloa*. The Brazilians principally exported *Hevea* at first. When I travelled there in 1898 and 1899 there were principally Brazilians extracting the *Hevea* rubber, but afterwards, I think, the Peruvians carried it on, so that it is comprehensible why *Hevea* rubber has been considered principally a Brazilian product.

Mr. CROSBIE ROLES: Could Dr. Castre tell us anything about the labour supply, supposing plantations were opened in the high country?

Dr. CASTRE: There are about one million inhabitants who could be induced by promises of food and work to fulfil any labour requirements on any plantations.

The Conference then adjourned.

The Rubber Problem in French Western Africa.

By AUG. CHEVALIER, D.Sc.,

In charge of Scientific Expeditions.

Dr. Auguste Chevalier delivered the following very interesting paper, as an evening lecture, illustrated by lantern slides.

Dr. Torrey occupied the chair, and there was a good attendance. The lecture was read in French.

The penetration of the Dark Continent by the principal civilized nations of Europe will be recorded in history as one of the greatest achievements of the nineteenth century. To explore in all directions, conquer and subdue this last great nest of barbarism existing on the surface of the globe, has required less than forty years! Not only has this vast domain revealed to us the contour of its surface, and the great divisional lines of its population, but we are now able to anticipate the principal economic possibilities it offers for human activity. The scientific inventory of Africa's natural resources is pretty well advanced, and many an earlier-discovered country has been less thoroughly prospected.

For centuries Western Africa only supplied the civilized world with gold dust, ivory, a few spices and condiments (Côte des graines), gum, and especially slaves. It is believed that during the sixteenth, seventeenth and eighteenth centuries there were exported from Africa by sea in the neighbourhood of 12 million captives; and this traffic in human cattle only ceased when the real occupation of the Dark Continent began, after the great exploring expeditions.

The civilized nations that took part in this occupation were actuated at first by social and political reasons. Only later was it seen that this conquest was destined to have vast economic significance. The progress of science has brought about the use of many tropical products heretofore unused: among these products stands rubber, which is still the only commodity of vegetable origin, exported to Europe from the interior of Africa.

Its first appearance on the West Coast of Africa market dates back some sixty years (according to J. Collins, to 1856). In 1860 rubber from the Coast of Guinea went through Gorće in transit and appears in the commercial statistics under the name of *gutta*. In 1870 this rubber represented the lowest commercial grade, its market value being 1·70 fr. to 1·75 fr. per kilog., sometimes only 0·85 fr.

After the discovery of rubber vulcanisation in 1842 the consumption of rubber increased greatly, but it is only since 1885 that African exports have become really important. For the last few years the quantity exported has varied from eight to twelve thousand tons per year.

In thirty years, then, Africa has exported some 250,000 tons of rubber, the value of which is sensibly equivalent to the market price of the 12 million natives sold into slavery during the three preceding

centuries. The natives have received in payment for this no less than 500,000,000 francs, and though part of this sum has been returned to the Colonial treasuries as tax money, the high balance remaining has served to increase greatly the welfare of the natives, especially in French Western Africa, where the Free Trade and competition obliged the European buyer to content himself with a small profit.

The annual rubber exports from our Western African Colonies amount to 3,500 to 4,000 tons. It is estimated that for the last few years the value of the rubber thus exported represents from 25 to 30 per cent. of the total exports of French Western Africa. In French Guinea rubber constitutes over four-fifths of the value of the exported products. This colony produces yearly about 1,500 tons. Sudan exports yearly, from Kayes, from three to four hundred tons of high-priced varieties. Casamance produces almost the same amount. The Ivory Coast supplies yearly 1,000 to 1,500 tons. Senegal and Dahomey produce only insignificant quantities.

A slight decrease in the rubber production of our West African Colonies has manifested itself these last few years. Will this decrease become more accentuated? Will the West African rubber, which comes on the European market in widely varying qualities, prove capable of improvement and be able to compete against the rubber from the Indo-Malaysian plantations? These are the questions with which we propose to deal in this paper.

Ever since 1898 we have been studying the rubber producing plants of Western Africa. For twelve years we have travelled thousands of kilometers through forests and over the vast plains where these plants grow. Numerous documents deposited in the Museum in Paris have been culled out; many observations, the greater part of them not yet edited, have been written down in our handbooks during our travels through the jungle. Furthermore, we have followed most carefully such experiments by the Government Agricultural Service, as well as by private individuals as have for their object better and larger production of this precious commodity. From these observations we shall select those facts which are likely to be of the most interest to the rubber trade.

It is known that the plants that produce the African rubbers are of numerous botanical species; these have, for the last fifteen years, been very closely studied. At least fifty species are known to yield a practically useful latex; but there are not more than ten that yield high class rubber and are sufficiently numerous to be worked wholesale. For the sake of clearness we may group these plants in five classes:

1. Vines yielding good quality rubber from the stems and sometimes from the roots. These again may be subdivided thus:

(*a*) Vines growing in the open.

(*b*) Vines growing in the virgin forest or on its border.

2. Trees yielding good quality rubber from their trunks.

3. Herbaceous or subherbaceous (grassy) plants whose underground parts (rhizomes or tubercles) alone yield rubber. Species of this class do not exist in Western Africa; therefore we shall leave them out.

4. Plants yielding good rubber but too poor in latex to allow profitable working.

5. Trees, shrubs and vines only capable of yielding highly resinous rubber of an inferior quality.

I.—(a) Vines Growing in the Open.

We classify the rubber yielding vines according to their habitat because as this varies the mode of exploitation must vary. Of the class we are now considering, our colonies yield only one representative—but that one of the greatest interest: *Landolphia Hendelotii A. Dc*—since it has yielded nearly 2,000 tons of excellent rubber every year since 1895. It is a variety which is essentially adapted to the arid life of the plains. It thrives particularly well on the stony slopes of the ferruginous tablelands, and is occasionally found on the border of the small strips of forest along the rivers of the Sudanese and Guinea zones. In these regions there is no rainfall for about six months during which time absolute drought prevails.

We studied this plant very minutely in 1899 at the time of General de Trentinian's mission. It is found in Senegal, as well as in Ndiander and in the Niayes, and is common throughout Casamance, in part of the Gambia basin, in Upper Falémé. It also occurs almost everywhere in French Guinea and at Sierra Leone, reaching its southern limit at about 9° 15′. On the Upper Ivory Coast it exists also in the Odienné, Tombougere and Lobi districts, but is not found South of the ninth parallel; it is common in the Sudan between the tenth and twelfth parallels; a few specimens are also found on the tablelands between Bamako and Koulikoro, as well as on the banks of the Bani River. Toward the East it is seldom found beyond Bobo-Dioulasso. It does not occur in Mossi, in Gourma, in Togo, or in Central Africa. Its reported existence in the last two localities is an error.

This vine has been exploited for some time, and the production of the districts in which it occurs has maintained the same figure, notwithstanding this long period of exploitation. In 1875 the southern rivers (Rio Nunez and Rio Pongo) were exporting 200 tons per year. Rubber-bearing vines were announced at Joal (Senegal) in 1882. Exploitation in Casamance began in 1883, and reached Fouta-Djalon in 1884. In 1890 Liotard and Rançon made known the fact that rubber was being collected in Upper Gambia and Upper Falémé. Dr. Chaussade, in 1895, learned that the sofas of Samory were collecting rubber in the Upper Niger district. Our officers had just entered upon the conquest and methodical occupation of the territories enclosed by the bend of this great river and they were soon attempting to call the attention of the trade to the resources of these countries. In August, 1895, in a circular addressed to the District Commanders, Colonel de Trentinian named rubber as the chief commodity to be demanded of the natives by the administration officers by way of *per capita* tax. The first lot, of 980 kilogs., from the South Sudan district, soon arrived at Kayes. The Kayes traders came to the auction sale, but the rubber was not very well received. It was bought by M. Touron for the firm of Devés & Chaumet at 0·50 fr. per kilog. This lot was sent to Bordeaux and very favourably received there. A few months later, quite a number of European traders went to the Upper Niger territories to operate on their own account. Since 1897 Sudanese rubber has sold, at Bordeaux, for from 8 to 9 francs per kilog.: yet it left a good deal to be desired, and in 1897 Commander Candrelier pointed out in a circular letter the desirability of training native foremen who could teach the natives, in the districts where rubber was not yet worked, how to prepare it properly. Commander Lartigue, in 1898, founded the first rubber schools while he was preparing for Samory's capture and the establishment of lasting peace in the vast territories composing the southern Sudan district.

It was General de Trentinian, however, who saw that first of all came the task of cataloguing the resources of the acquired territory and that this must be committed to specialists, who should determine what were the useful raw materials and find the most rational methods of exploiting them. We were fortunate in being intrusted with this investigation which is still in progress under the patronage of the General Government of Western Africa.

In 1899 we stated the location of the principal Sudanese growths of *Landolphia Hendelotii*, which lay mostly in the districts of Kouroussa, Kaukan, Sikasso, and Bobo-Dioulasso. At the time we passed through the two latter districts exploitation had barely started, but it soon developed. Exports from Sudan were in 1895 30 tons, in 1897 60 tons, in 1898 120 tons, and reached about 300 tons in 1899.

We applied ourselves mainly to the task of studying the best ways of tapping the vines and of coagulating the latex, and Administration circular letters ordered these methods to be taught in the rubber schools which had just been founded.

The *Landolphia Hendelotii A. Dc*, known in Sudan by the name of *Goïne*, in Senegal by the name of *Toll*, ordinarily occurs in the open in the form of a bush branching at the base, and often spreading to a greater diameter than its height. On the other hand, on the borders of the forest it is found as a vine, sometimes 20 meters long. The *Goïne* grows very slowly in the dry districts of Sudan ; from 10 to 15 years are required under favourable conditions for the vine to reach a diameter of from 4 to 5 centimeters, when it can be tapped. We estimate the average production of a vine that has already been tapped at 50 gr. of dry rubber per year, the vine being tapped twice yearly. Teisonnier obtained a higher yield from ten-year-old vines at Konakry, where the rainfall is over 4 inches. As for the damp districts, like Casamance, we consider the figures given by Henry as to the yearly yield of a full grown *Landolphia* as very near the truth, *i.e.*, 80 gr. for the vines and 29 gr. for the bushes. The most favourable times for tapping are :

1. The end of the rainy season (October and November).

2. The period of great cold and nightly dews (December to February).

3. The beginning of the rainy season (April and May).

In the brush, early morning is the best time for tapping, because the latex almost stops running as soon as the sun warms the vine. The most rational process of tapping consists in taking off the surface bark in transverse strips from 5 to 10 mm. wide, in length not more than one-third the circumference of the stem ; these tappings are "staggered," leaving a space between them of 30 cm. (lengthwise). In the centre of each strip is made a V-shaped incision lightly touching the cambial zone. If these incisions are not too deep new ones may be made six months after in the space between the old ones.

The latex is first collected in leaves, or in calabashes, and afterwards poured into bottles. While the latex is flowing the native can tap other vines in the neighbourhood and put calabashes under them as well.

Where the vines grow thickly together an active native can prepare from 300 to 400 gr. of rubber a day.

The latex of *Landolphia Hendelotii* coagulates very easily. Part of it even coagulates on the incision and forms a kind of scrap, which the native pulls off with his fingers and mixes later on with the prepared

rubber. The latter is usually obtained by adding to the latex, without heating, a decoction of the leaves or fruit of certain plants rich in acids and tannin.

The coagulants to be recommended are decoctions of Niama leaves (*Baukinia Reticulata*), or of the fruit pulp of the tamarind (*Tamarindus Indica*), or of native sorrel (*Hibiscus Sabdariffa*). The use of salt solutions practised in certain districts should be prohibited since it causes the rubber to become sticky. On the other hand lemon juice gives good results. Weak solutions of citric acid may also be used, and one firm has adopted the happy expedient of distributing this reagent among the natives with whom they trade.

Goine rubber makes its appearance in the shape of strips rolled up, called *twists*, also in small balls, which are made of fine ribbons rolled one on the other and called *niggers*. The kind most in demand consists of small balls dried in the huts and slightly tainted by smoke.

The quality of the Guinea and Sudan rubbers has greatly improved during the last fifteen years, and great efforts have been made by the Administration and by the local trade in that direction. The Governor of Guinea in 1908 prohibited by statute the exportation of wet rubber made from bad quality latex, as well as of rubber containing too many impurities. Rubber carried by the caravans was frequently inspected by the agents of the Administration on the road and in the market places. Frauds were punished and the bad rubber confiscated. Superior sorts then came to the factories in larger quantities, but no sooner did the supervision become less rigorous than the native fell into his old ways again.

More or less successful trials have also been made towards improving and increasing the natural plantations. Our *Landolphia* is admirably adapted to the Sudanese climate and takes a great variety of shapes according to the physical conditions under which it grows. In the stony, open and arid soils it develops very slowly. For the first few years it mainly thickens its taproot, which becomes almost tuberous, and soaks itself with water during the rainy seasons, thus enabling the plant to resist the long droughts. Only after the root system is well developed does the young stem, during the rainy winter, become a few decimeters longer. Then it shoots out a few tendrils and begins to look like a small vine. But great dangers still threaten it. The teeth of the herbivorous animals, the grass fires, or too long a drought, may destroy the exposed parts but the root goes on growing. *Landolphia* can react for a number of years against such accidents, but the plant often perishes. The natural stocks of *Landolphia Hendelotii* find it more and more difficult to maintain their existence in face of the constantly-extending clearings and the brush fires. It is a certainty that the vines found in Sudan to-day, sometimes on the top of naked and arid hills, have grown there at a time when the forest clearings were less extensive and the fires more local. The best way to bring back the natural conditions and thus assist the natural growth is to eliminate the human element by establishing forest reservations where fires are absolutely prohibited.

It would therefore be necessary:

1. To adopt some such protective measure as the formation of a native supervisory staff whose business it would be to clear, toward the end of the rainy season, large fireguards around the reservations, to stop the spreading of the forest fires.

2. To prohibit all hunting on these reservations and to exclude all persons liable to cause damages.

3. The trails leading from village to village should be diverted so as to go around the reservations.

4. Punish all infringements of these regulations.

5. Allow the working of the vines through tickets distributed in the surrounding villages—which are most interested in preserving and extending the natural stocks.

Vuillet noticed in 1909 that the plantations in the Sikasso-Bobo-Dioulasso districts had greatly improved since 1903. To-day the tapping incisions only extend halfway round the vine, and a space of 15 cm. is left between them. The plants are no longer tapped from the roots. The natives protect their stocks and do not allow them to be damaged by strangers. The natural plantations have, in certain places, even been staked out. Some natives prepare rubber in strips (without rolling them up) in such a way that they are much cleaner and dry more thoroughly than when stuck together in balls. The managers of the European firms in the interior take greater care than formerly in the handling of the rubber. The warehouses are more spacious and better aired ; grids have been arranged and spread on these the rubber loses much of its moisture. Large balls are purchased only after being cut, in the seller's presence, to see whether they are sound inside.

The efforts made in the rubber schools to induce the natives to prepare " slabs " have not been successful. This is explained by the fact that the greater part of the rubber coagulates on the stem and the latex cannot be collected in mass. The vines from the uplands which have been tapped years since, only yield a few drops of latex to each incision, and this coagulates at once in contact with the air. Those growing in damp valleys and in the small forest islets give a more regular yield, but such vines are not abundant as a rule.

Plantations of vines by native communities which we have advocated since 1899 have not given results, and we now doubt whether they should still be advocated considering the small returns and the fire risks. In any case such plantations should only be established in rich and well irrigated soils, carefully cleared of brush and fenced in. We cannot expect the underbrush to be kept down as it is in the forests of our own country ; but the natives can be made to prevent the grass fires, the only scourge which really damages the natural plantations.

The vines treated as is already done in Sudan and protected against brush fires will yield a normal production indefinitely, for as fast as the branches are exhausted the new shoots will be ready for tapping.

I.—(b) The Vines of the Virgin Forests.

Vines yielding good rubber are numerous in the African forests. In those of the Ivory Coast, to which we shall confine our attention, there are only two species of any importance : *Landolphia Owariensis* and *Clitandra Elastica*.

1. *Landolphia Owariensis* is very closely related to *L. Hendelotii*, only it is adapted to forest conditions. Its frail and twining stem throws out abundant casual roots near its base. It rises, describing numerous curves and entangled with other vines, or supported by trees, to a height of 30 or 40 meters, but if its branches were stretched out it would have twice or three times that length. Having reached the top of the highest

trees, thus passing through two successive stages of vegetation, the branches of the *Landolphia* subdivide indefinitely. The small leafy branches make a drapery which envelops the head of the supporting tree and often reaches from one tree to another in such a way that the virgin forest seen from above looks like an immense green and hummocky prairie, the intervals between the tree tops being filled in by vines whose varieties may be numbered by hundreds.

These vines are, however, rather sparsely distributed. Where *Landolphia* grows most abundantly one would hardly find more than one well-grown specimen to every 30 or 40 meters. On the other hand, in the semi-darkness of the underbrush there are many small plants of the same species, with stems as frail as those of the hop vine. These are, as a rule, not more than about one meter high, and they are only waiting for an opening in the forest in order to develop themselves. Among the plants which are held back in this way through lack of light, only very few manage, by lengthening excessively their exceedingly frail stems, to rise above the first stage of the forest and finally to the top of the highest trees. This being accomplished, however, these plants are saved ; they spread an enormous number of branches to the sunlight ; the leaves with which they cover themselves begin actively to assimilate carbon ; then, only, does the stem begin to increase in diameter.

Landolphia Owariensis is exceedingly adaptable. Generally the stems reach a greater diameter when the vine grows either near a clearing or along the edge of the forest, and in the strips of forests along the rivers of the Guinea zone, where the plant has not far to go in order to reach the light. Vines growing in such places also yield a larger quantity of latex.

On the high tablelands of Fonta-Djalon, where the forest has probably always existed (except on the ferruginous uplands) *Landolphia Owariensis* is found as a bush, very similar to those of *Landolphia Hendelotii*, the two species growing side by side.

The bushes are very low and often blossom less than one meter high. In the Middle Congo jungles, especially in the neighbourhood of Brazzaville, they are called *Landolphia Humilis.* Finally, in Upper Chari (Country of the Senoussi), where grass fires rage every year, the aerial parts of this plant are still further reduced : the very slender stem grows as an annual only and has no tendrils, but the subterraneous rhizomes become highly developed. They then constitute a real rubber bearing grass. We shall here consider, however, only the forest growing specimens. These, as we have said before, are often very much scattered about. The branches, as soon as they are a few meters high, reach out and entangle themselves with other vines and with the branches of the supporting trees ; very often they are thus entangled with certain rattans having very thorny stems and leaves. Under these conditions the forest vines can only be tapped as high as a man's head, and the quantity of latex which is obtained is small for it has been proved that an incision in a *Landolphia* vine causes only the latex which is near the wound to flow. Then, again, forest vines have an enormous length and their stems are often of the same diameter from the base to the top, where they begin to subdivide in numerous branches ; therefore the exploitation methods used in the open cannot be used here. It is very difficult to climb trees around which the vines twine for reasons given above, and the only way the native can gather the latex and obtain the greater part of the rubber contained in the vine is to cut it down. He first severs the main stem either level with, or at about

an arm's length above, the ground, then he pulls the end which is fastened to the trees, and with mighty jerks manages to draw to himself a considerable portion of the stem, which he cuts in short pieces. Sometimes, aided by the vine stems, he climbs the supporting trees and severs the stem of the vine close to where it starts branching. The stems of *Landolphia* are often so very much entangled that without cutting them from the top end it is impossible to secure them by simple pulling.

The *Landolphia Owariensis* stems, or trunks, are then cut up into small sticks of 30 to 40 cm. long, and each end is placed over a cup made of leaves, which collects the latex: it then only remains to gather and coagulate it, which is usually done by heating to boiling.

The process of gathering latex indicated here only yields a small portion of the total rubber. The greater part remains either in the bark of the cut branches or in such branches as are left hanging in the tree-tops and cannot be reached. We estimate that the native exploiter, or *poyofoué*, gathers only a quarter of the rubber existing in the cut vines and loses the other three-quarters. We may therefore inquire whether it would not be advantageous to exploit the forest vines by "cutting and threshing" the dried bark, afterwards eliminating with water all that is not rubber—as is done in the case of the plants producing "grass rubber."

We have attempted to ascertain the time required for this operation in the Ivory Coast forests. A vine of medium thickness, cut in small ends, gives for 8½ kilogs. of dry wood about 3 kilogs. of dry bark. Cases have been known where this bark contained as much as 5% of rubber, but in many cases it only contains 1%. We think that in the most favourable season 2% of rubber would be an average yield, that is, 150 grs. of rubber for 3 kilogs. of bark. Stripping the bark from the billets by hand with a knife is a slow operation; a native took two hours to prepare the 3 kilos., the threshing took ½ hour. We leave out of account the cutting of the vine into billets, the drying, and the transportation of the bundles of sticks, operations which also require a certain amount of time; a load of *Landolphia* wood freshly cut represents barely 200 grs. of dry rubber, therefore it will not at all pay to carry these bundles a long distance.

The extraction by mechanical treatment of the bark would be practical if the operation could be done on the larger scale by machinery, in a locality where the vines grow abundantly; but it is easy to show that such an undertaking by Europeans would not actually be remunerative. It could only be done on an extensive plantation containing 1,000 vines per hectare at the most. Now it is known that these vines, cut, after ten years' growth, at the most favourable season, level with the ground so as to allow them to shoot again, would only contain about 400 grs. of rubber per vine, or 400 kilogs. per hectare. A factory that would produce 10 tons of rubber per month, or 120 tons per year, would have to cut, each year, 300 hectares of plantation. It would be eight years before these vines could be cut again and then they would yield once more 400 grs. of rubber per plant. It would, therefore, require a plantation of 2,400 hectares divided into lots of 300 hectares cut once every eight years to feed the factory. It is needless to insist on the expense entailed by the management and the working of such an acreage. For these reasons, then, we believe that the methodical working of rubber-bearing vines in the forests (where *Hevea* and *Funtumia* can grow as well) has but small chance of success; and we would better

let the natives go on cutting the vines, which will either grow again or be replaced by others capable of being worked after a few years.

2. *Clitandra Elastica.*—The *Clitandra* species, like *Landolphia*, produces a good quality rubber in various forest districts of tropical Africa. The best known species is *Clitandra Orientalis* of Eastern Africa and the Congo. On the Ivory Coast this variety is represented by *Clitandra Elastica* and *Clitandra Micrantha*, which are probably only different varieties of the former. The latex from these plants i exceedingly fluid and the substances that coagulate the latex ot *Landolphia* have here no effect. To obtain rubber from *Clitandra*, the natives collect the latex in bottles and coagulate it afterwards by heat. The product obtained is of poor quality when first made, but its elasticity seems to increase afterwards. Later on, it turns dark, hence the name of *black rubber*, given to certain varieties of the Congo.

The rubber-bearing *Clitandra* are found throughout the forests of the Ivory Coast, as well as in Kissi and in other wooded districts of Upper Guinea. They constitute a latent wealth hitherto almost untouched by the natives.

II.—Native Trees Yielding Good Quality Rubber.

Only one variety of native African tree is of much interest as a rubber producer, and that one is *Funtumia Elastica*, which is distributed all over the great African forest reserve, from Sierra Leone to Uganda, and from British Nigeria to the South of the Equator. In Western Africa great natural plantations occur in a large portion of the Ivory Coast virgin forest, and also in those parts of French Guinea which touch the Republic of Liberia.

The exploitation of this species began in 1878 on the Gold Coast, but only reached the Ivory Coast about 1892 or 1895. This exploitation spread gradually from East to West. In 1909 we saw, in the basin of the River Nuon (Upper Cestos) magnificent patches of very old *Funtumia* which had not yet been tapped ; but wherever exploitation has spread it has caused the adult *Funtumia* trees to disappear very rapidly. Some are cut level with the ground by the natives in order to extract their maximum yield, others, tapped too frequently, die standing. At last there only remain young *Funtumia* trees, under 15 years of age. These are still very numerous all through the forest. The *poyofoués* of most of these forest districts have to-day no other resource but the tapping of these young trees and the vines which they previously neglected.

Does this mean that *Funtumia* is bound to soon disappear from the African forests ? We do not think so. The tree possesses most remarkable power of spreading. The seeds, having egrets, are carried afar by the wind and often germinate abundantly in the forest clearings, especially on the site of the old native plantations, and in open spots. Even when the trunk has been cut level with the ground by the *poyofoué*, or has dried up after too many tappings, *Funtumia* will still keep alive and give off shoots which will become a tree after a few years. M. Farrenc, an agricultural engineer of Ivory Coast, has based on these observations a proposed method of working forests rich in *Funtumia* trees, by which, forest plantations could be worked with a small capital. He proposes felling the trees on a ten years system, thus allowing the spontaneous restoration of the stock of trees by offshoots and natural seeding. During the first ten years he considers that the plantation would contain 400 *Funtumia* trees per hectare ; at the close of the second period, 800

trees could be utilized ; and at the third turn-over the plantation would contain about 1,000 trees per hectare and reach its maximum production.

Funtumia rubber, when well prepared, becomes as valuable as that of *Hevea*. The coagulating process which has given us the best results is boiling with water. The cold latex is gradually brought into pure water nearly at the boiling point. In three minutes the coagulation is complete. The rubber is then kneaded while still warm by means of a rolling pin or a bottle.

The yield of *Funtumia* varies greatly according to the age, the climate of the district in which it grows, and also according as the tree has or has not been tapped before. We have seen full-grown trees, probably a hundred years old, with stems 20 mm. long and 70 cm. in diameter, which, cut down by the natives at the beginning of the rainy season, produce as much as 8 or 10 quarts of latex, yielding 2 or 3 kilogs. of rubber. It is, however, frequently the case that full grown trees give a maximum of 500 grs. of rubber for the first tapping, while young trees of 10 and 12 years old give 100 to 150 grs. at the very most. Tappings made six months or a year afterwards produce still less. *Funtumia* is essentially a forest tree, and forms the lower level of the great African forest, where there is a yearly rainfall of from 1·50 to 2·50 meters. Under these conditions it gives its greatest yield. When cultivated outside the forest the tree becomes much thicker set, branching very near the ground and produces less latex. *Funtumia*, unlike *Hevea*, bears continued tapping very badly, and, so far from increasing its yield and its capacity for producing rubber, it scarcely yields any latex at all when tapped only a few days after a previous tapping. Moreover, the thin bark is very delicate : it heals slowly ; and if the cutting tool has penetrated the cambium at all, the tree pines and the whole trunk may wither.

Nowadays the natives tap the *Funtumia* trees "fishbone" style, the incisions reaching from the bottom to where the tree forks. The side furrows cover about two-thirds of the surface of the trunk, and are from 0·25 to 0·30 meters apart. These furrows are never opened again. Six months (sometimes a year) after the first operation a new tapping in the fishbone shape is made on the side of the trunk opposite to the first one. Only a small quantity of latex is then collected. The following year the fishbone tapping is made near the first furrow, and so on, cutting out the longitudinal channel on the least damaged part. The tree very seldom resists these operations long. It withers after two or three tappings, and there is nothing left for the natives but to tap younger and younger trees, which have not yet been worked and whose yield is small. This explains how the rubber yield of a forest territory after having reached a maximum, begins to decrease.

Within the last few years attempt has been made to find a possible way of obtaining a higher yield from *Funtumia* without damaging the tree. M. Bret has made some very interesting experiments on the Ivory Coast, and has come to the following conclusions :—

If the tappings, as performed by the natives, are not repeated too frequently, and do not cross one another, as they often do, the tree is able to resist. It then remains to find the right time intervals between tappings and to proportion rightly the incisions. Owing to the continuity of its laticiferous tubes, the thinness of its bark, and the high fluidity of its latex, *Funtumia* behaves quite differently from *Hevea* on tapping. Opening up old wounds in a *Funtumia* tree gives but poor results. An incision made between two lateral furrows 0·45 to 0·50 m.

distant, gives nothing, immediately after the first tapping; the flow only reappears twelve hours at least after the first operation, and is then very weak. It only becomes appreciable three days after the tapping and is the more abundant as the oblique incisions are the further apart. A new operation only gives really good returns after the wounds have been well healed up; that is, eight months at least after the first operation. M. Bret concludes that by tapping the trees moderately with proper instruments, cutting the bark only in strips from 2 mm. to 3 mm. wide, leaving reasonable time between the treatments and diminishing the total length of the incisions, the tree may be preserved and the yearly yield may even be increased. One side of the tree could be treated every six months, and only after several years would an old incision be opened again. Treated in this way *Funtumia* would be preserved indefinitely. One could count on two tappings each year, and a yield of from 60 to 75 grs. of dry rubber from trees from 5½ to 6 years old, and at the end of the ninth year the returns would be from 200 to 450 grs. of dry rubber for each tree.

These returns are certainly very inferior to those given by *Hevea* trees, for it is generally admitted that the Brazilian tree gives one kilo. of rubber when 10 years old, but it should not be forgotten that this rubber is obtained after very many tappings, so that a given weight of *Hevea* rubber costs at least six or seven times more in labour than the same amount of *Funtumia* rubber. The latter species, therefore seems to be exceedingly valuable for the forest districts of tropical Africa, especially when the facility with which it multiplies is taken into account. Besides it is not impossible by judicious selection, and crossing varieties richer in latex and more resistive may be obtained. It is, then, important to multiply studies in all the African agricultural stations, on this valuable tree, which might become, at least in tropical Africa, the rival of the *Para* tree.

Ficus Vogelii Miq.—Some twelve years ago there were high hopes of this tree, which is distributed all through Western Africa from Dakar to the mouth of the Congo River, especially in the coast districts. It is now admitted that its rubber is only second quality, for which reason it has been neglected except in the districts where they make "lumps." It is exploited extensively in Lower Cavally, and also probably in the parts of the republic of Liberia, along the coast. *Ficus Vogelii* sometimes occurs as a tree with a tortuous stem, from 3 m. to 5 m. high and from 20 cm. to 50 cm. in diameter, and sometimes as an epiphyteous plant starting in the fork of a tree and whose branching roots go down to the ground and bury themselves therein after having described more or less regular windings round the supporting trunk. According to the natives this epiphyteous variety is much richer in rubber than the other. It is mainly found in the swampy parts of the forests, from the coast to a distance of 30 kilometers inland. To exploit it the natives cut down the whole tree by cutting the casual roots as well as the stem of the supporting tree. When the tree is on the ground the aerial roots, and the branches, which are at least as large as a man's arm, are tapped by making annular incisions 20 cm. apart from one another. The latex which flows is caught in small cups or simply in large leaves whose contents are poured afterwards into cups.

The latex is coagulative by allowing it to stand for a few days. The rubber obtained is slightly elastic, has no nerve, and contains fragments of bark as well as drops of serum. A single tree yields as much as 10 kilogs. of rubber.

In several districts of the Sudan zone there is found a second variety of *Ficus*, *Ficus Bibracteata* Warb., whose latex gives a second quality resinous gum, more or less similar to gutta, but of little commercial value. Within the last few years Northern Nigeria has exported this in fairly large quantities.

Plants Yielding Good Rubber but in Too Small a Quantity to be Exploited.

Several plants belonging to the *Asclepiadeæ* and the *Apocyneæ*, contain, in their bark, good rubber, but in too small a quantity for extraction.

E. de Wildeman some time since pointed out that *Periploea Nigrescens* was a rubber-bearing plant. The rhizomes and the lower portions of the branches contain very small quantities of elastic gum; the aerial branches contain a caustic latex sometimes used for poisoning arrows. The same is true of another Asclepiad, *Omphalogonus Calophyllus*, which occurs in the forest districts of the Ivory Coast and Dahomey.

Finally, we have also some time ago described, under the name of *Carpodinus Utilis*, an Apocynea, growing in lower Ivory Coast, whose rhizomes and slender stems also contain rubber; but the quantity of latex which flows when they are tapped is so small that the natives do not think of working them.

The same is true of *Clitandra Mannii* and some of its relatives in the great virgin forest of Africa.

Trees, Shrubs and Vines Yielding Resinous Gums of Second Quality.

Certain districts of the West African forest where rubber bearing trees and vines have become scarce owing to intensive exploitation continue nevertheless to yield larger and larger quantities of rubber—which the trade buys, but then finds to be poor in quality. This depreciation in the quality of the rubber from certain countries has been laid to the natives bestowing less care on its preparation, but this is not so, as we have been able to ascertain during our recent explorations in the Ivory Coast forests.

This depreciation is the consequence of adding to *Funtumia Elastica* latex other latices from a very different class of plants. These latices when coagulated by themselves give a gum resembling more or less "dead Borneo," and of very little value. A few years ago such admixtures were uncommon. The natural plantation of *Funtumia Elastica* were still rich, and the native tapped only this tree and the *Landolphia Owariensis* and *Clitandra Elastica* vines. As the natural growths of rubber bearing species became exhausted by too intensive an exploitation the native hunted out all the varieties he could find in the forest whose latex could be used, and thus he began to mix the inferior latices with the latex of *Funtumia*. By mixing these in well determined proportions and by coagulating them in a certain way he obtains a substance which looks like rubber but is a long way from having its value. That is how "Ivory Coast Lumps" and the "Gold Coast Accra Paste" are made. We have recently given the names of the trees and vines whose latices are used in the preparation of these products. They are mainly large trees, capable, if worked on a large scale, of producing thousands of tons of guttoid resins or gums having the appearance of rubber. Among the most common of these and the richest in latex we may mention *Funtumia Africana*, *Alstonia Congensis*, *Chlorophora Excelsa*, *Antiaris Africana*, *Morus Mesozygia*, and several species of *Ficus*. Among vines

Carpodinus Hironta, principal producer of the "Accra-paste," *Landolphia Florida, L. Thompsoni*, and several species of *Clitandra*.

An industrious native can gather as much as 10 quarts of these mixed latices in a day, especially if he goes to work early in the morning, when the flow is most abundant.

The coagulation consists in boiling the mixed latices for some time, or adding various products to them and then churning or whipping them. The process which is used the most now by the natives consists in pouring in the latex which requires coagulating the syruppy latices obtained from certain *Apocyneæ* belonging to the *Strophanthus* and *Alafia* species. The mixture is stirred with the hands and after a few minutes becomes a mass of pseudo-rubber.

The plants which supply the substances we are speaking of are very abundant in the forests and in the plains of West Africa, and they can cater to a very extensive trade whenever the trade finds a way of using these resin rubbers.

Conclusions.

We have now enumerated all the natural sources of rubber in Western Africa. These sources are well known to-day, and there is no hope of discovering new ones. Besides this, the producing plants are worked nearly everywhere now in our different colonies, so that the production by working the naturally growing plants is not likely to increase much. It is, in fact, doubtful whether the production will always maintain itself at the present yearly figure of 4,000 tons.

We hope, on our part, that this figure will still be reached for a number of years, and even surpassed, provided our administration is very vigilant in watching the natural plantations which are worked exclusively by the natives.

Efficient measures have already been taken in several regions. In Upper-Senegal-Niger, for instance, where *Landolphia Hendelotii* grows, the administration has attempted since 1904 to preserve and even to extend the actual stock of trees (1) by protecting them against brush fires; (2) by prohibiting the collecting of latex during certain periods in the most worked districts; (3) by obliging the natives to reset vines in the territories where they have been tapped too intensively; (4) by causing vines to be seeded in the fallow lands near the villages.

Finally, the administration is also seeking to improve the quality of the product by gradually bringing the natives into the way of forming the rubber into strips instead of balls.

To this end practical rubber schools have been founded with the aim of teaching the natives how to cultivate rationally the *Goine* vine, and how to collect and prepare it to the best advantage. Important results have already been obtained. Artificial plantations of some importance are established in the provinces of Sikano, Bobo-Dioulasso and Bougousii, but the oldest ones are only from 5 to 6 years old. "Red Niggers" from Sudan were priced at 19·75 frs. in May, 1910. The cultivation of rubber vines has been tried in French Guinea for over 10 years, but the brush fires have annihilated nearly every plantation. On the other hand, the experimental garden at Camayenne has made interesting studies, which give some hope for the cultivation of *Castilloa* and *Funtumia* in the Conakry district. It has also demonstrated that from 100 to 150 grs. of rubber a year in two tappings could be obtained from the *Goine* vine worked regularly when 10 to 12 years of age. This figure is low compared to the yields from *Hevea*, but the work of collecting the latex is far less.

The rubber question presents itself in the Ivory Coast under far more varied aspects. The trees and vines in the virgin forest do not suffer from brush fires, but they are more exposed to damage by the natives, who are less civilised than is the case in Sudan and in Guinea. First of all it should be forbidden to cut down *Funtumia* trees in the districts where this practice still prevails. It is hard to work the forest vines without cutting them, but the places where this is done should be most carefully watched, and closed, if necessary, to foreign harvesters. The quality of the *Funtumia* rubber could also be greatly improved. This would mean inducing the natives to make this rubber in slabs without adding to it other latices, which might lower its quality. Latices producing second quality resin rubbers, of which there are so many in the forest, could be coagulated separately ; a product would then be obtained which could be sold under a special name so as to avoid confusing them with the first class quality rubbers which this colony is capable of producing. These improvements of course will be hard to bring about, but the local Government of the Ivory Coast already encourages the increase in rubber production as it did formerly the cultivation of the cacaotree by the natives.

We have now to say a few words about the rational cultivation of rubber plants in West Africa. Unfortunately, the first attempts at cultivation are in their infancy. Cultivation of *Hevea* extended enormously in Indo-Malaysia and even began to gain a foothold in French Cochin-China, but Western tropical Africa remained almost entirely outside this movement. Yet vast countries like Gaboon and the forest districts of the Ivory Coast possess a very similar climate to that of the Amazon country, where *Hevea* grows wild.

Why did not the French capitalists and colonists interest themselves earlier in the cultivation of rubber in West Africa, and why were they so ready to go to the Far East ?

An important reason has kept them away from tropical Africa. It is not, as some claim, the fear of not finding the required labour. The labour is crude, but all who know the districts of interior Africa well, especially Sudan, know its availability. To our certain knowledge not a single undertaking has come to grief in French Western Africa through the lack of native labour.

What did keep back all those who would have given themselves to the cultivation of rubber on the West Coast of Africa was the absence of technical data, based on previous decisive experiments. Such preliminary experiments were made long ago in Indo-Malaysia by admirably-equipped scientific establishments, such as the Botanical Gardens at Calcutta, Singapore, Buitenzorg, and Péradénga. These establishments have not only introduced numberless new plants, but the colonial Governments of the Malay Peninsula, Java and Ceylon have started cultivation on a large scale. It was only after the rich returns of the cultivated *Hevea* had thus been demonstrated that individuals in turn started extensive plantations. As these extended, new problems came to the front. It was found that *Hevea* trees secreted latex very irregularly. This led to the idea of making selections for seeding. The best way of tapping the trees had also to be determined. When the first ailments appeared ways and means to fight them had also to be found. Scientific establishments like these we have enumerated —and they alone—could solve such problems, and they are still engaged in such studies.

Needless to say that, so far, not a single institution exists in West Africa that can compare with those in Malaysia. About twelve years ago a certain number of experimental gardens and agricultural stations were started, but these establishments have only a precarious existence; no ties connect them with one another. The experiments made there are not properly managed and are almost never followed up. Very seldom, then, do they bring forth practical results. With regard to rubber plants, the experiments have been made on such a small scale and under such unfavourable conditions that it is not possible even to-day to draw any practical conclusions from them. From the results of tappings made on a few *Hevea* trees planted in the Ivory Coast and Lower Dahomey one cannot be optimistic. The same with regard to the *Funtumia* plantations. Here we have in Africa a native tree of prime value, but how many problems there are in its cultivation and exploitation!

To solve them it will be indispensable to carry out in all our African colonies long series of experiments, conducted in a really scientific manner, and on a very large scale. One or more Botanical Institutes provided with a competent scientific staff, and located in suitable districts should supply to the stations the seeds for these experiments, as well as the technical information, the general directions as to the plants to be tried, and the methods to be followed; in other words, the scientific institute, while leaving to these stations a sufficient initiative, should see that their work progressed methodically toward the practical goal to be reached.

The idea of establishing Institutes of the kind for each group of colonies is making headway every day in the French colonial centres. Eminent statesmen have proclaimed their necessity. We therefore hope that before long French Western Africa will be endowed with an African Buitenzorg, whose work will greatly help in forwarding civilization on the Dark Continent, for, in the words of Minister Turgot, one of the most illustrious French economists of the eighteenth century, "To introduce and multiply new products and new industries in a country is one of the greatest blessings one can give, and is at the same time most satisfying to the conscience."

Notes on the Planting and Production of Rubber in Ceylon.

By Mr. KELWAY BAMBER.

Professor Calmody, director of Agriculture, Trinidad, in the chair.

The CHAIRMAN: I have been asked to take the chair in the absence of the regular chairman and it is unnecessary for me to say any words in introducing Mr. Bamber to you.

Mr. KELWAY BAMBER then read his paper as follows: There has been no great change in the methods of planting *Hevea* rubber since the previous exhibition, and although a good deal has of late years been heard of wider planting, the average number of trees per acre may still be taken at about 150, obtained by planting 12 ft. by 24 ft. or 15 ft. by 20 ft. Such planting in Ceylon does not appear to check the development for the first few years, and gives a more rapid protection of the surface soil from the sun's rays and direct rainfall. Wider planting with from 40 to 48 trees per acre will no doubt in time give larger and more productive trees, capable of renewing bark freely, but, to date, the closer planting methods have been more remunerative and for those countries now planting *Hevea* it would still be the wiser policy to plant at least 100 trees per acre. Much has been learned of the different yielding capacity of the various *Hevea* trees to be found in Eastern plantations and for future planting a careful selection of seed should be made from trees with the best yielding variety of bark. It has been found that there are two or three distinct types of bark, two of which yield well, while the third gives hardly any latex. The first two are of a distinct brown colour, usually with a corky outer layer and showing a pink tinge or section. The latter is a smooth grey-coloured bark with a greenish tinge, and is usually thinner than the others. Microscopical examination of these barks has shown no great difference in the proportion of laticiferous tubes, so that the difference in yielding of latex is difficult to account for. Luckily for Ceylon the proportion of these poor yielding trees is slight, but when found all such trees should be removed to prevent crossing with the better varieties. For the first two or three years, especially in soil requiring much drainage, the greater proportion of *Hevea* trees show a distinct grey bark, which darkens and becomes more corky from the base upwards after that period. This must not be confounded with the other type of grey bark, though it is often difficult to distinguish in the younger stages. After the third year the bark of the better types of trees increases considerably in thickness. When rubber first began to be planted on a large scale it was usually estimated that no returns would be obtained under five or six years, but it has been found in many instances that the trees were of sufficient girth to commence tapping in or after the fourth year and that with careful work, no harm to the tree resulted, but should the trees at this early stage be overtapped serious harm might follow.

A favourite system, first tried on Lanadron Estate, was to commence with a basal V tapping, embracing half the circumference of the tree and 15 in. from the ground, and with another V 12 in. to 15 in. above it, if the girth of the tree permitted. This is now frequently employed, with various modifications as to the proportion of the bark tapped, and while in many cases it gives satisfactory yields, it affords a means of gradually training the coolies to do good work before the bulk of the trees come into bearing. At the present price of rubber, early tapping will not, of course, be so profitable, but it will still have the advantage quoted above, and will increase the girthing capacity of the tree. I think there is no doubt about that, that with careful tapping of young trees—though one does not like to recommend it generally—there is a decidedly more rapid increase of girth than when the trees are left alone. A point, however, that has to be borne in mind is whether such rubber is really suitable for ordinary manufacturing purposes, and in any case it should always be packed and invoiced separately, and every precaution taken that it is not put into lots of older and possibly better vulcanising rubber either in Ceylon or in England. It is evident from facts gained at this exhibition that the greatest harm may result to the plantation industry generally if precautions in this and similar lines affecting uniformity are not taken.

The spiral form of tapping has now almost entirely gone out of practice, especially since Professor Fitting's able brochure was published. Latterly also the old system of pricking and paring is also disappearing, as it has been found that better yields are obtained by paring only and with less injury to the trees. The evidence is, however, not conclusive and some of the finest work has been done by the combined tools followed by excellent healing of the bark. Professor Fitting demonstrated by his experiments that the supply of plant food to the stem, etc., was interfered with to a large extent by the spiral or half-spiral and similar methods of tapping and recommended that opposite quarters only should be tapped to minimise this effect—a suggestion that is being freely adopted. I do not know if you have seen Professor Fitting's pamphlet on the subject, but he says there is no doubt a considerable interference with the ordinary circulation of the sap takes place under the present system of tapping. In young trees it is better to tap only one-third of the circumference at a time, as with opposite quarters the length of each cut is not sufficient to get a good flow. In both cases it is necessary to adjust the distances between the parallel cuts so that the bark will last the required number of months, and twenty cuts to the inch may be taken as an average. If a third of the bark is tapped during the first year, or say an 18 in. tree at 3 in. at the end of the year the girth would be about 23 in. to 24 in. when opposite quarters could be tapped if considered advisable. In tapping by the paring method only it must be remembered that the bulk of the latex tubes are situated close to the cambium so that the blade must go fairly deep if the latex is to be extracted. A minute fraction of an inch in this respect will make a great difference in the year's output and the closest supervision is required to see that the cambium is not injured by going too close. I have heard of instances where the superintendents were congratulated on the beautiful work they have done, their trees looking so well, but it was found that the tapping had been so shallow that the yield had been poor. That was why the bark had healed rapidly, but it was not so profitable as it might have been. The native tappers, as a rule, become wonderfully expert at their work, and any that do not should be put

to other estate work. Each coolie should be given his own particular line of trees or area for tapping for obvious reasons. A good coolie would not like his tapping spoiled by a bad workman, and the work of each man is under better control. The renewal of bark has so far been very good and although one has heard that the fourth renewal is disappointing on some estates in the East, it can only be in cases where each renewed bark has been tapped before maturity and probably where the trees are too closely planted to allow sufficient root space as well as air and light. We may expect a gradual lengthening of the period of bark renewal after each tapping, but opinions are completely changing as to the actual time required. Formerly it was considered that no renewed bark should be touched under four years, and had this been adhered to there would have been little fourth renewal for some years to come, but it was found that a good flow could be obtained, even after the second year and tapping was accordingly renewed at that period to obtain more rubber while the prices were high. If in certain cases the bark is not renewing well after the third removal it may be taken that tapping has been too rapid for the general vigour of the tree, and the period allowed for each renewal should be extended a few months. It is a point, however, that I am sure need not cause much anxiety, as we now know that the *Hevea* tree responds wonderfully to cultivation and manuring and that if done on scientific lines a sound renewal of bark can be insured. A gradual thinning out will no doubt take place year by year in all rubber estates, partly from the accidental loss of individual trees, but chiefly by carefully removing those trees showing the poorest yielding capacity. The best way to effect this is to pollard such trees at 8 ft. or 10 ft. and continue tapping them another year, or so long as they yield remuneratively. They can then be entirely removed with the aid of stump extractors and so prevent risk of loss from root disease.

In order to prevent the interference with circulation which undoubtedly occurs under ordinary systems of tapping, experiments have been conducted at Peradiniya with a new incision method with so far very satisfactory results. It consists in cutting shallow vertical channels down the bark from 6 ft. to the ground, incising these at 1 in. intervals and collecting the latex at the base of the trees in the usual way. The method, which is evidently still capable of improvement and modification, is performed as follows :—Two of the channels are cut the first day at opposite sides of the tree and incised with the special blades at 1 in. intervals from top to bottom. After missing a day, two more channels are cut $\frac{3}{4}$ in. to the right of the first two, and incised as before, and this continues on alternate days until the whole circumference of the trees has been channelled and incised. The trees are then rested for six weeks and the incisions repeated on alternate days in the same channels, but $\frac{1}{4}$ in. below the previous cuts. After each complete round of the trees they are rested for the six week, so that on the average the trees are only tapped on 72 days in the year, in six periods of 12 days. During the six weeks rest the coolies can tap other areas in the same way. The yields obtained compare very favourably with the ordinary systems of tapping as over the one acre on which the first experiment was made an average yield of 1 lb. 3 ozs. of dry rubber was obtained during the year. The rubber is growing at 1,600 ft. in a rather dry climate and was $4\frac{1}{2}$ years old when tapping commenced, and every tree except a few one or two-year old supplies, was tapped, where as under ordinary methods only trees over say 18 in. at 3 ft. are taken into bearing.

The process has the objection of increasing the proportion of scrap rubber, but if this is collected at once in buckets of water to protect it from the air and heated to 180 deg. before rolling, the rubber is as good as that made direct into crêpe and if smoked can hardly be distinguished from it. Another point observed was that with the rapid increase in girth of the trees, the width of the channels increased in proportion, and in cleaning them with a knife before each the tendency was in places to go unnecessarily deep although the latex tubes were rarely touched. After a long drought, however, a heavy fall of rain produced so much internal pressure that in places the weaker spots gave way, the tube bursting internally, forming an inch square sheet of rubber, the patch of bark outside dying. In all cases these spots soon healed perfectly level, but modified experiments are now being tried to lessen even this slight risk. At the end of the year, the trees were perfectly healthy and yielding better than ever, while they continued to flow in the dry season when by most other methods of tapping the trees had stopped flowing entirely. The question of tapping during the driest months which are usually associated with the leaf-fall, has been much debated, but from my experience it is advisable to completely rest the trees for two or three weeks, especially when the new leaves and flowers are being forced. It rather tends to upset the routine working of the estate, but for the permanence of the trees it is advisable. The latex may have something to do with the leaf and seed formation. You find the branch full of latex, and it is a question whether it has not been carried there to be utilised in the form of flowers and subsequently the seed. I think it is generally recognised that where a tree is seeding very freely it does not yield so well and we certainly know that where you overtap a tree your latex fails and probably the seeds deteriorate tremendously, being much smaller and not germinating in the same proportion ; so that there seems to be some connection between the latex and the seed formation.

I do not want to go into the question of manufacture which has been admirably shown in the cinematograph exhibition, or into the merits of the various processes and of crêping, sheeting, etc., or the advisability or otherwise of smoking either the latex or the prepared rubber. Numerous experiments are being conducted to try and ascertain which method gives the most reliable and useful product for the manufacturer. The hope or expectation that at this exhibition the manufacturers would be in a position to tell us in what form they preferred the rubber to be sent has not been realised, for the simple reason that while one manufacturer prefers one form, others prefer different forms for their various purposes, so that for some time to come crêpe sheet or block will be required. What one can inform planters generally is the absolute necessity of uniformity of treatment to produce an article not only uniform in appearance, but uniform in quality and vulcanising properties. No doubt many experiments will still have to be made in the East to obtain the best results, but where new coagulants or methods are being tried, such samples or breaks should be kept separate, even if equal in appearance to the ordinary make, otherwise the vulcanisation of a large stock of goods may be spoiled, and the manufacturer would naturally refuse to take the mark again. It has been found, after many experiments, that certain marks require certain mixtures, and temperature and period of vulcanising so that the aim of the planter must be to produce an article of the same standard throughout the year. Much has to be learned as to the cause of the

variations in vulcanising properties and numerous experiments are being conducted to ascertain the reason, experiments that will have to be continued over a prolonged period and confirmed in several ways before definite conclusions can be arrived at. I may add that some of the results of these experiments are most promising, but it would be premature to lay down any rule or any suggestion for modifying the present manufacture until we have had the results confirmed in every possible way.

There is one more point I should like to briefly touch on with your permission. I have been frequently asked what I thought of the present condition of the industry as an investment. When one realises the vast possibilities in the use of rubber when at a reasonable price, there is little ground to fear over-production for many years to come. In England the public do not realise the number of factors at work, which may and probably will prevent the huge exports that are calculated on the area said to be under rubber. Very large areas will probably never come into bearing owing to want of labour, not only to plant the trees, but to maintain them in a condition to reach a profit-bearing stage. I have seen several areas in the East which have been taken up for rubber and floated as companies—I am glad to say not on this side of the world—and as far as I can see several of them will never give any return. Other areas also will probably not give anything like the sanguine estimates expected either from the same or similar causes affecting the growth and tapping of the trees. On the other hand all estates opened on suitable soil, on sound lines, should give remunerative returns for many years to come even if rubber fell to 2s. or even 1s. 6d. per lb. (to-day's price being plantation 5s. 9d., hard Para 4s. 10¼d.). With a fall in the price of rubber, greater economies will be effected in its production and marketing, as in the days when the cost of tea manufacture was reduced from about 1s. to 4d. per lb. I do not care to give any definite figures of profits per acre, but at a very low estimate from £15 to £25 per acre per annum may be expected, the latter figure being about the cost of bringing an acre into bearing. It will be seen, therefore, that there is every prospect of very remunerative returns, especially if the price is maintained at anything like the present figure. (Applause.)

The CHAIRMAN: We have had a most interesting paper and one which I am sure lends itself very much to discussion. I hope the discussion will be full and free. We have got the enormous advantage that Mr. Kelway Bamber has got his facts at first hand and has related them in the practical way one would have expected.

Mr. WICKHAM: It is with a considerable amount of diffidence I follow Mr. Bamber's interesting and carefully written paper based on actual experience, but at the risk of appearing to reiterate matter that I have given already in another form so many times, I would like to emphasise my feelings with regard to this system of close planting in the East. I really look upon it as a matter of very serious menace. The trees obviously have no chance under existing conditions of obtaining their natural development. They have the risk of becoming root bound and otherwise impeded in their natural growth, thereby laying themselves open to loss of vitality and to danger of receiving the spores of fungi, because the tropical jungles are full of spores of fungi, and when the tree is brought to a low state of vitality it lays itself open to infection in this way. I really think that is a point that should be more closely considered. Another point Mr. Bamber brought forward is the matter

of seed. I think that is a thing very much neglected. Seed should be collected from the better producing trees. Another point, more of interest than value, is the matter of bark colouration. That is interesting to me because, throwing my mind back to the 'sixties, I remember it was a very marked thing among *Hevea*, this variation in colour; so much so that we used to groom our trees before we began to tap them. When groomed the tree was almost milk white, but in other cases it was almost russet, so that there are considerable variations. In a matter of tapping, I was more than pleased with a visit I paid to Mr. Bamber when I was passing through Ceylon and saw the tapping there. I am immensely pleased that he is beginning to recognise the contention to which I have always adhered, and that is the method of incision as against excision—the removal of the growing tissue. I am only too pleased he has taken this point up, and I hope he will throw his ability and energy into it to a successful issue, because I am quite confirmed in the opinion that incision will replace excision. It is almost unthinkable to my mind, to expect a tree of the natural habit and order of the *Hevea* to continue to renew bark tissues year in and out over the whole time of its natural life. Here is a tree that might go on for 50 or 100 years, and supposing even it renews its bark tissue satisfactorily for a given number of years, one would suppose it would gradually diminish that power. There must be a time when it will cease to give you the working material, and if Mr. Bamber will continue his investigations on the incision method, I think he will avoid those risks. I am perfectly satisfied from my own working that he will increase his yield. Another point that Mr. Bamber referred to was to the method of curing. Perhaps I should not renew remarks I have made with regard to the smoke cure, but I am still perfectly satisfied that it is bound to come. The methods in the East now are founded on curdling coagulation, and therefore producing what we might call a rubber cheese. The method I have been accustomed to in making hard cure is the utilisation of the essential oil from certain smoke and making glazes and films. Our efforts in that process are to avoid coagulation. As soon as coagulation takes place it is put on one side and is in the form of negro-head. There is no reason why the principle should not be adopted in the East. An allusion was also made by Mr. Bamber to the manufacturer who is loth to give any public opinion. He is quite satisfied to buy in the open market. Many have spoken to me and assured me from what they have seen of a small sample of latex from the East made up by the smoke cure that it was likely to meet their requirements. They want uniformity, and with a smoke cure you will get uniformity. It does not matter whether you make five or 5,000 tons, it will be all the same and they will know what they will get.

Dr. STEVENS: I am sure we are all indebted to Mr. Bamber for the very interesting paper he has read. He has mentioned one or two points which are relatively new. I do not remember having had a distinct statement made previously as to the difference in the yielding capacity of the different plantation *Hevea* trees, having different colours of bark. I should like to ask Mr. Bamber whether there are any other distinctive features he has come across in addition to the colour of the bark, and is it possible to distinguish trees by colour of the bark even when the bark is covered by lichen, which is usually the case in plantations? Then the second point is with regard to the damage to trees due to tapping in the dry season. I should like to ask Mr. Bamber if he has

any distinct evidence of that, of trees which have died or been seriously injured through tapping in the dry season? As regards the yield of latex and the yield of flower and seed, at first sight it would appear that if tapping the trees in the dry season prevents a large yield of seed that would not be a great drawback. We would rather have rubber than rubber seed, but, of course, there are other aspects of the question. With regard to suitable seed, I should like to ask Mr. Bamber if he considers it advisable to start a small plantation of trees in the middle of a forest far away from the plantation so that there can be no chance of cross fertilisation, with a view to providing good seed for future requirements?

Mr. CLAYTON BEADLE: I am glad to see that Mr. Bamber and Mr. Wickham have again supported those who emphasised the necessity of uniformity in production of plantation rubber. I believe it is a very good rule so far as it can be carried out with any kind of rubber. I remember a remark made by one of the leading manufacturers who has had experience in all qualities and made a scientific study of it, and who said that with regard to low class rubbers he would willingly pay 15 per cent. more for a uniform quality than he would be prepared to pay for what showed a considerable variation, because with considerable variation in quality he never knew how to deal with the material when he got it, and it would be worth that much more to him if he could ensure its uniformity. It is not so much a question as to high quality or low quality, but of the uniformity of any particular kind of rubber. I understood Mr. Bamber to agree with the view that the true estimate of rubber can only be ascertained when its properties in regard to vulcanisation are properly studied. In regard to plantation rubber in relation to hard cure Para, is not the best evidence we can have the relative prices of those two commodities on the market.

Mr. SUTER: I should like to ask what the difference is between incision and excision? The second point I was going to raise has been mentioned by Dr. Stevens, and that is in regard to seed nurseries. It is proved that there is a direct connection between the flow of latex and the growth of flowers and seed there might be a great danger in it, but the seeds could be kept from deteriorating by having nurseries.

Mr. TUDHOPE: I think it is unfortunate we have not a larger attendance, as this is one of the most practical papers that have been read. Speaking from my own experience, I can heartily endorse many of the points raised by Mr. Bamber. In our plantation in West Africa the trees of which some came from Ceylon and some from Malay, we find several varieties of bark. We are only in the initial stages of tapping, and there is undoubtedly a great difference in the yield. We have smooth bark and rough bark, and I think it is an important point that there should be seed selection from good latex-bearing trees. Of course, in the early stages of an industry seed production is important. A very important point was made by Mr. Bamber with regard to tapping young trees. I understand he is of the opinion that tapping young trees tends rather to increase the girth of the tree than to injure it. That is an important point to the planter, because it enables him to commence tapping early without any fear of injuring the growth. With reference to this new method of tapping, I think, that as far as West Africa is concerned, the method by which Mr. Bamber obtained 1 lb. 3 ozs. from 70 tappings is an important point. I want to see a system perfected whereby we can tap less frequently than on the present-day system. There is no

fear that on the West coast we shall be able to produce as much rubber per tree, and equally as cheap, as in the East. Another point made by Mr. Bamber was with regard to careful tapping. He spoke of a case where the superintendent had been congratulated on his method of tapping but had not got a big yield of rubber. In conducting experiments, unless there is great care taken to see that they are really getting the maximum amount the experiments are not of any use. With regard to uniform quality, it has occurred to me that probably the system adopted in Denmark with regard to milk might be followed with regard to latex. In Denmark central factories are established, and the milk collected there. You would have to put in charge of such factories highly qualified men, but you would be able to produce rubber in tons where you now produce it in cwts. I do not think there will be any difficulty in sending the latex to such factories.

Mr. Clayton Beadle: It occurs to me that in mixing the latex together in that way there would be the difficulty of ascertaining the proportion of rubber from each estate.

Mr. Tudhope: That would be for the chemist.

Mr. Beadle: It would be a big matter to place in the hands of the chemist, and he would have to be of exceptional ability. A slight percentage would make a big difference.

Dr. Huber: I should like to know what is the feeling as to the change of foliage. As I understand it is not in the dry season but at the beginning of the dry season or the end of the dry season, because the trees drop their leaves at the end of the rainy season and change their leaves at the beginning of the dry season. I may add, with reference to the colour of the bark, I have observed that in some regions there are some red and some grey, and generally the red is less rich in latex. The red and scaly bark is characteristic of all the inferior kinds of *Hevea*.

Mr. Golledge: I did not hear the whole of the paper, but having seen the trees which Mr. Bamber has been experimenting upon in the garden, it would appear that so far they have maintained their health and are looking well. At the same time it would appear to be a very drastic operation, more so than ordinary excision. Before we can say anything as to Mr. Bamber's system it is necessary to find out how far the tree will be injured and what the result will be over a number of trees. Mr. Bamber, I think, mentioned that early tapping tended to expand the girth of the tree. I think that is so. A speaker on my right suggested the transportation of latex to central factories, but in view of the fact that we are doing everything to save labour in the field it seems to me an impracticable suggestion.

Mr. Tudhope: We have found it very successful in Ayrshire as applied to butter. It is the smaller producers that will benefit from the factory system, and I see no objection where the estate is near to the railway and there are easy means of transport.

Dr. Stevens: May I just say a word on that matter? I take it that where you have milk from different farms the milks are practically identical in composition.

Mr. Tudhope: It is paid for on quality—percentage of cream and fat. It is for the chemist to invent methods in regard to that.

The Chairman: I will call upon Mr. Bamber to answer the points raised. It is quite evident his paper has been fully appreciated, because

the discussion has been most valuable, and many important points have been brought out in connection with that discussion. There is one point I would like to ask Mr. Bamber, if he would be kind enough to give us the information, and that is whether they go on tapping while the tree is seeding? On the question of uniformity, it seems to me that the system proposed by Mr. Tudhope presents a good many difficulties which I think would prevent its being carried out. So far as I can see, what is likely to happen is that we shall have estate marks for the product of the estate and the owners of the estate will themselves be the best judges of what grade they could put their different kinds of rubber in. The analogy between cows' milk and the milk from rubber trees is not quite the same, because you do not tap the cows some at five and some at 30 years. There is not the same variation of age. At all events, the testing of milk is carried out much more easily than the testing of latex. The same proposition has been made in connection with sugar. Assuming the amount of sugar in the juice brought in and dividing it proportionately, occasions a great deal of difficulty, and I am sure it will be more difficult with latex. With regard to uniformity of composition, one thing that struck me with Mr. Smith's machine was that planters were able to get uniformity with that machine, and I have recommended to the Government of Trinidad that as we are beginning the industry and having a small quantity only at first, we should make our rubber in a uniform way and turn it out of uniform quality, naturally distinguishing between the ages of the trees and in connection with our *Castilloa* we should have to give the percentage of resin present. That is one of the difficulties we have which you do not have in *Hevea*.

Mr. Bamber: With regard to Mr. Wickham's views on close planting, I am quite with him up to a certain extent, but we have to look at things in the East from the commercial point of view, and though theoretically it would be excellent to have trees at the wide distance he suggests, it is necessary we should have them sufficiently close to give a good yield per acre at an early age. Mr. Wickham's claim is that 40 or 50 trees per acre would give us as much as 150 trees to the acre.

Mr. Wickham: Half a chain, not an inch more.

Mr. Bamber: It has to be proved, and I do not know of any place where it has been tried. When you consider the methods of cultivation and the risk of the loss of trees after three or four years, if there are only 40 or 50 trees to the acre it makes a considerable difference in the yield. With regard to the question of incision, I quite agree with Mr. Wickham that it is a process that may come into general use. At the same time I would not recommend anyone to adopt the system we are trying on any large scale until it has been proved for at least two years. What we wanted to learn was whether bark renewed from below only gave as much latex as the bark renewed by the total removal of the bark. We know that where we cut away bark daily the renewed bark gives more latex than the original, partly because the tree is older and it yields better. It remains to be proved whether the bark renewed under my system of tapping will do the same. As far as I can gather, from experiments that have been going on for 13 months, it promises to do so, but it is too early to recommend the system on a large scale. In the new experiments I have done away with the channel by marking the tree with chalk or pencil and pricking up the mark. The coolie wets it so that the latex as it runs out runs down the wet line. This answers

very well in dry weather, but it is not very successful after a heavy shower of rain, as the latex spreads all over the bark. With regard to experiments on the Brazilian method, we have tried it in Ceylon and I certainly think there is a lot in it if it could be done on a practical scale, but at present we have not devised a method which will ensure complete coagulation and put it on the market in a serviceable form. I hear there are several patents out which promise to do this. Dr. Stevens asked if there was any other difference in varieties of bark. The only thing I could remember is that the grey bark has invariably a green tinge under the grey. The grey is not due to lichen growing on the surface. It is a grey surface with a green tinge underneath, and as a rule the bark is slightly thinner and much harder, but microscopical examination does not show that there is any great difference in the laticiferous system. With regard to stopping tapping for the formation of seeds, one would not recommend it. That is not the idea. What happens is when you tap in dry weather the coolies are every day removing the bark and getting no return, so that it is merely wasted bark. I have seen many estates in dry weather and you get hardly any drip into the cup, whereas under ordinary circumstances the cup ought to be one-eighth or a quarter full. I have not seen any trees die from tapping in dry weather, and I do not think it is likely, but the time has come when planters must realise that it is a waste of money and capital to cut away their bark unless they are getting sufficient latex to pay for it, certainly in the dryest weather when there is often no flow at all. With regard to isolated plantations for seed purposes, it is an excellent idea if we could find the land sufficiently isolated in Ceylon. They might do it in Malay with better chances of success. We have, of course, hundreds of acres of forest land, but it is mostly in a climate where Para does not do well, and we are not certain that seed raised in an unsuitable climate would give us the type of tree for which we are aiming. As far as possible I recommend everyone to select seed for future supplies and plantations, because that will make a great difference not only in the time of bringing the estate into bearing, but in subsequent yields and renewal of bark. Mr. Beadle mentioned about uniformity, which I have strongly urged since long before the previous exhibition in London. It seems to me the manufacturers' chief difficulty lies in not being certain that they are going to get the same thing they have been experimenting with. The manufacturer makes his experiments at considerable cost and trouble, and he hits off a mixture, but if he cannot be certain of getting the same class of rubber repeated his expensive experiment goes for nothing, and he has to test again. But I think it is merely a question of time. As estates increase in size and methods get more uniform the difficulty will be overcome. I quite agree that analysis does not show whether the rubber is going to vulcanise. I have analysed many hundreds of samples from trees of all ages and different methods of tapping, and the variation in the analysis has not been sufficient to draw any definite deduction as to why the rubber should not vulcanise. We have sent samples to the manufacturer which we have thought would vulcanise well and prove a strong rubber, and this has not always proved to be the case. In fact, many of our weakest rubbers have vulcanised better than the strongest, and much has to be learned in this respect. Mr. Suter asked if incision was the same as excision. In making the channels the object is to cut the slightest possible channel ; it is merely to guide the latex, and there is no excision of the laticiferous tubes. The channel is cut one-sixteenth of an inch deep and a hard-pointed tool used to clean

it out, instead of a knife. With incision for actual tapping there is no removal of bark. Mr. Tudhope spoke about seed production and how the various barks gave different results. As I pointed out in my paper, it is very difficult in the earlier stages of plantation, up to three or four years, to state what the rubber tree is going to do, but in four years, when trees begin to branch more freely, they alter their character entirely and acquire the reddish brown bark which is generally found to give the better results. I was surprised to hear from Dr. Huber that bark with a red colour was less rich in latex, because that is quite contrary to my experience in Ceylon, where the reddish brown barks invariably give better results. As regards basal tapping, as Mr. Golledge said, it does increase the girth, but I would warn any one who starts it that it must be carefully done. You must not go in and say " Tap these trees daily." The work must be carefully done, or instead of getting an increase of bark you would injure the tree for some months. In my method of pricking I tried to devise some method for preventing the blade touching the cambium, but I found it impossible. There are no two trees with the same thickness of bark, so that I made the knives very sharp and then saw that if they did touch the cambium they would only make a clean incision, and I am waiting to see whether it will affect the bark injuriously. So far there has been no harmful results. With regard to centralisation of latex, it sounds very pleasant and no doubt would be of great advantage to manufacturers if they could get rubber of a more uniform character in bulk, but from what I know of the difficulty of transporting latex I do not think it is quite practicable. We find that unless formalin is added at once as it comes out of the tree the acidity developes so largely that there is a large clot in the bucket; therefore by the time it reaches the factory it would have accumulated a lot more rubber round it, and would lead to endless difficulty in judging the amount and quality of the rubber. There is not the slightest difficulty in estimating the amount of rubber in any bulk of latex. About two or three years ago I had a bottle made which held the 100th part of a gallon, and if this is filled with latex and a drop or two of acid added, you get a clot of rubber with clear separation of the latex water. This can be washed with the fingers under water, then put through a small roller, or weighed on a scale and you can read the percentage of rubber. It is a simple process, and I think will gradually come into use. I think the time is coming when planters will have to stop tapping trees if they find the proportion of rubber falls below a certain amount. I have visited estates where the proportion was up to 30 per cent. or 40 per cent., and I have been to the same estate when they have had less than 10 per cent. It is only a matter of resting a week or a fortnight to bring it back to a normal proportion, and a test such as I have mentioned would enable planters to know when they should rest a particular field. Dr. Huber asked about change of foliage. As a general rule, in the district I am speaking of it varies considerably. We have the north-east monsoon from October, November and December, and half of January, and the leaf falls very soon after that. In February the new leaves and flowers begin to form. We get slight rains in March, a little in April, and May and early June are hot and dry, but by that time the trees are in full leaf again. I should like to be quite certain I heard from Mr. Huber that it is the red bark that gives the less latex.

Dr. HUBER: I spoke of red bark, which is generally considered as of less quality. The red bark is a light red and generally scaly at the same time. It is found on the inferior trees. Generally it is considered

that the light bark is inferior to the dark, but it is partly due to the position because the light bark is always produced by lichen in the light, and the dark in the dark forest. The Chairman asked whether one stopped tapping while seeding. We never do, and personally I do not think there is any necessity for it. We want the maximum amount of latex.

The CHAIRMAN : It is not necessary for me to do more than express our very hearty thanks to Mr. Kelway Bamber. The afternoon has been very hot and the discussion has been lively, but I am sure you have been very much interested.

CHAPTER II.—SECTION II.

(I.) HAROLD HAMEL SMITH.—"The Need of Organisation in the Supply of Literature and Labour for Rubber and other Planters."

(II.) GUSTAVE VAN DEN KERKHOVE.—"Official Measures Against Adulteration of Wild Rubber."

(III.) W. CARNEGIE BROWN.—"The Maintenance of Health in Rubber Planting Districts."

The Need of Organisation in the Supply of Literature and Labour for Rubber and Other Planters.

BY HAROLD HAMEL SMITH.

Editor of "Tropical Life," author of "Soil and Plant Sanitation on Cacao and Rubber Estates," etc., etc.

Leaving others to deal with such matters as how, when and where to plant rubber, which way to tap the trees, or how to manure or keep them free from disease, I would like to say a few words on the pressing need of securing better organisation in the matter of obtaining the labour necessary for working rubber and other estates, as well as of placing before those interested complete monthly lists of the books, pamphlets, reports, etc., on agriculture generally, as well as those which specially deal with the crops, and how to treat them, whether such publications be issued officially or by private individuals.

Taking the last item first, most of us have noticed that books, etc., as above described, are now being issued almost daily, many of them being of prime importance. The average man interested in planting, however, is generally too busy to be able to keep in touch with, much less to trace back such books, etc., as published. If, therefore, a central Bureau of Agricultural Publications could be established in London for those engaged in rubber and other agricultural industries, on lines similar to the one already established at Washington, U.S.A., I am certain much valuable information, that otherwise gets hidden away and lost, would be brought regularly before those connected with the various agricultural industries.

The lists themselves if properly drawn up in the first place, and if carefully filed by the recipients on the the other hand, are very useful to refer to should they at a future date require to see what has been published on any given subject. Within a few pages hundreds of publications could be listed, and this would often save the expense of international or inter-departmental overlapping, or the issuing of more than one report on the same subject.

The International Agricultural Institute of Rome, the outcome of the International Congress on Agriculture summoned hence by the King of Italy, issues a monthly review of the principal books on agriculture generally, but this does not seem to cover reports, bulletins, etc., besides which the book of reviews that they issue is altogether too ambitious and far more costly than the simple lists that I advocate. All that is needed is a list of the publications, with name, author, price, postage, and publisher or where obtainable. Such a list to the rubber-producing world, if issued regularly, must save much time, and, most important of all, bring prominently forward much valuable information that is in danger of being buried away and so lost to the world at large.

As regards the organisation of our labour supplies, probably there is nothing new in what I am about to say ; many of you may have said the same thing over and over again. As, however, we do not seem to be making much progress in solving the difficulty of obtaining regular and reliable supplies, I feel that you will pardon my bringing up the matter before this Congress. I do so because it is of prime international importance, and so befits the occasion. If Malaya needs, as some assert she does, 1,000,000 labourers, these have to be withdrawn from other centres—India, Java, China, etc., etc.—where their absence will be remarked, probably resented, and finally prohibited. India already, in spite of the fact that thousands of her people are more or less in a chronic state of semi-starvation, a state which climatic or other conditions at times aggravate until the loss of life owing to the lack of food or money to buy it is absolutely appalling, is restricting the recruiting of her people to work on estates elsewhere*, and other countries seem likely to do the same if they have not already made a start. This, I contend, is due to the absence of any International agreement on the matter. Surely it is to the interest of us all, *i.e.*, to everyone engaged directly or indirectly in tropical agriculture, to bring about some agreement as soon as possible.

Meanwhile the producing centres show signs of suffering from the want of these very people of which India, taken as a whole, and Bengal

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* The *Madras Mail* pointed out a little time back that planters in India have more than a passing interest in the labour troubles of their brethren in the Straits Settlements and the Federated Malay States. For one reason the yearly output of rubber from that part of the world, which will probably be the determining factor as regards rubber prices in years to come, will depend on the supply of labour there ; and in the probable event of the Dutch Government prohibiting the emigration to the Straits from Java of indentured labourers, following the example of the Government of India, the Rubber Companies will have to choose between free labour from India and the Chinaman. At present, fortunately for planters in India, the latter seem most in favour, in spite of his independence, the high scale of wages he demands, and the language difficulty, which is likely to prove a serious drawback. The first batch of Chinese emigrants to Malayan rubber estates reached Singapore from Hong Kong a short time ago. Only about sixty coolies arrived, but owing to scarcity in parts of Southern China, there are said to be plenty more available. The *South China Morning Post* suggests that the Government of Hong Kong should take an interest in procuring the 1,000,000 coolies who will be required, it estimates, for the Malayan rubber estates, and in directing a constant stream of others to make up for vacancies. If this scheme means that Southern India is to be freed from the attention of the Straits recruiter, the agriculturist on this side will wish it every success. It is also stated that when arrangements are made for Chinese coolies to be repatriated at the end of their contract, a better class of labourer can be obtained, and, in accordance with this dictum, the Planters Association of Malaya recently passed a resolution favouring the principle of repatriating Chinese coolies, provided the indenture entered into makes the importer, and not the employer, liable for the cost thereof. See also the rather sharp controversy now raging between South India and Ceylon, because the latter persists in recruiting Indian labourers from districts which the South of India planters maintain not only require the men for themselves, but could well do, in their turn, with an increased supply—" Lots of land were lying idle in the Tanjore district," we are told, " because of coolies emigrating "—or, again, Mr. M. E. Couchman, I.C.S., Director of Agriculture, Madras, draws attention in his Report for 1909-10, to the present prosperity of the Madras cultivator, for which the high price of cotton is largely responsible. It would seem, he adds, that the labourers have not participated to a proportionate extent in the increased prosperity of their employers, but an advance of agricultural wages is necessary in the near future. The Board of Revenue has little doubt that if employers of agricultural labour would only allow their landless employés to participate much more largely in their increased profits due to the high prices of produce, by raising the wages of labourers, and in other ways ameliorating their condition, much difficulty connected with labour would disappear (in India).

in particular, has an over-supply. Both sides suffer for the want of a little organisation and tact. What I want you to consider therefore is whether we cannot, between us, devise some means of relieving the wants of both parties—those needing money for services rendered and those able and willing to pay a fair wage for a fair day's work.

Although this is an International Congress, I think that I shall best serve the cause I am pleading for by minding my own business, *i.e.*, by treating the matter from our own point of view and using India as the chief example to explain my view, leaving our friends from other countries to state their views and requirements, their hopes and expectations, on the subject. Since the Rubber Exhibition of 1908 there have been many complaints, mostly from laymen, of alleged unsatisfactory methods employed in handling the raw labour provided by native races in the tropics, especially in speeding it up to the level of what the more hustling white man considers to be a fair day's work. Whether these complaints have been justified or not, they certainly, from what I read in the columns of my exchanges, are causing the free flow of native labour to be seriously curtailed, and in many instances to be stopped altogether. Surely such a course, since it can only bring inconvenience and trouble in its train, should be, and could be, rendered unnecessary. Because a few estates or centres treat their local or imported labour in an unsatisfactory manner everyone should not be punished on account of the few, and yet this seems to be the tendency. Rather let the few, and their number in comparison is small and rapidly diminishing, be punished, and, if necessary, severely punished, so that the greater number (and through them, be it remembered, the trade of the Empire as a whole) is not hampered and kept back.

The complaints have been aimed pretty well all round at our own planters in one part of the globe, and those under other flags elsewhere. After studying the statements of the more persistent and aggressive of these critics, the following queries suggest themselves :—

1. Are the natives on the whole ill-used, or even roughly handled, to an unnecessary degree ?

2. Are the grievances only on one side, and have both sides, employers and employed, equal opportunities of securing justice, and if not—why not ? Whose fault is it that such defects exist ?

3. At the chief producing centres are the labourers adequately remunerated, taking into consideration the cost of living, the general level of comfort on the spot, and the quantity and quality of work obtained in exchange for the wage paid ?

4. Why is it that in face of Protectors of Immigrants being appointed, the work they are supposed to do is often adversely criticised, so that the supplies of natives are curtailed and even stopped ? In a word, why, and in what manner, do these Protectors fail to satisfy the various Governments, at home, and in the colonies, who employ them ?

5. When the answers to any of the above questions go against the planters, can their critics suggest other and more satisfactory methods for obtaining and safeguarding the labour required to develop the tropics, and enable them to yield a fair return on the £50,000,000 already invested in rubber planting alone, to say nothing of the other industries ? If they cannot suggest improved means to bring this about, is this large amount of money to be sacrificed, and the large sums it would cause to be paid in wages lost to the natives, simply because the European has

not yet had time to evolve a method of handling his raw native in a manner satisfactory to all, viz., those interested in the matter financially; the native; and the arm-chair critic at home?

It is much easier to find fault than to suggest practical remedies. Whilst the law is very busy insisting that everyone must be kept alive when sickness and disease is rampant, is it not, at the same time, rather slack in pointing out how the people are to be fed when cured of their disease? What does it benefit the native to be cured of an illness only to starve afterwards? If by our laws and regulations we increase the population by keeping children and adults alive, it is certainly our duty to see that work, when such work can be found, is placed at their disposal, and that the native, adequately safeguarded, be made to do it. White planters, on their side, cannot be expected to pay wages for inadequate work, and if the labourers show signs, on account of home-sickness, or indolence, of preferring to be hard-up and even half-starving, or of being kept at public expense (a little weakness by no means confined to the labourer in the tropics), because they are not paid above the value of the service they render, they should be compelled to work and to do their share in making the world go round, rather than allowed to become a burden to themselves and others. India from all accounts would suffer far less from plague and famine, if some 2,000,000 of her people were transferred to other tropical centres, where their services are badly needed, and in these days when miracles are being performed in other fields, it certainly seems strange that these 2,000,000 should be left to starve in India, and to cause as many more to do the same.

To-day, compared to ten and twenty years ago, sees the danger of famine aggravated as the cost of food everywhere is steadily and permanently rising, whilst the average income *per capita*, although higher than it was, has not increased to a corresponding extent. The increased cost of living, on the top of increased populations, and heavier taxation necessary to keep us alive, will continue to rise, and, therefore, it is our duty to see that outlets are supplied to work off, either the surplus males alone, or of whole families, from the congested centres, where they are not wanted, and transfer them elsewhere, where their presence will be an advantage to themselves and others. Arrived at their new home, they need not stop there permanently, unless they wish to, although it is wonderful what a large percentage prefer to do so; but they must agree to stop a certain number of years, during which they can, and do, accumulate considerable sums of money, which they use with benefit to themselves and also, in the aggregate, to India or wherever they come from, if they return home.

Strenuous efforts are being made in India, to raise both the standard of living, as well as the methods of cultivation employed, and the manner in which the ryots prepare their crops. Now nothing would help forward so necessary a reform as to induce as many of the people as possible to visit other centres, where they can learn simple, scientific methods of cultivation, etc., and be trained to realise the advantages of adopting them. The Indian ryots are slow to change their ways, until they are dead certain of the benefits of so doing. Trusting nobody, they believe in nobody, and ask for no man's advice as how to do, or not to do, their own work. It is only by proof positive that they can be induced to alter their methods. Here, therefore, is another important reason for organising the labour supplies of the tropics, and for guiding and moving it out of the rut it is in, to the benefit of the natives themselves,

and of the world at large. If they are not pulled out of their rut, they will sink to so low a level, that like the Australian aborigines they will become extinct, and the tropics will be the poorer for a loss that should not be allowed to come to pass. It is high time, therefore, that a start be made, otherwise Nature and necessity may cause a movement to take place along lines that are beneficial to no one, and if this does happen, the blame would rest on those who were more ready to find fault than to remedy the disease.

Last month in an article that I wrote† on the need of larger and more reliable supplies of labour in the tropics, I urged that in order to take advantage of the millions already invested, as well as to encourage further sums to follow, something must be done to bring about the better organisation of our labour supplies. There are thousands of miles of fertile land being starved for want of the crude labour necessary to work it, whilst there are millions of suitable labourers who would benefit by being placed on that land. Surely with a little care, tact, and consideration in handling the natives, the two can come together. The chief centres of the world are getting congested, just as they have done before, and want a shake-up to distribute their children more evenly over the whole surface. Let us be warned in time, therefore, and do by peaceable methods what has too often been done by force and fighting. Modern social history can be said to have started with such an upheaval in France in 1789. Modern scientific and industrial development began fifty years later, in 1839, with the utilisation of steam and mechanical appliances. Now, seventy years after the introduction of steam, comes the turn of the tropics and the coloured races, to be utilised for their benefit and that of our own people. Empty stomachs have caused, and always will cause, more trouble in this world than hot heads, and when one looks around it cannot be denied that in nearly every portion of the globe important social upheavals, especially among the lower classes, exist. Let us, therefore, take the opportunity to open up, with our capital, the sluices leading to fresh channels of employment, and at once start diverting the stream of surplus labour, from here, from India or elsewhere, whether under our flag or not, so that we shall assure our tropical planters and colonial agriculturists a sufficient and reliable labour supply of all nationalities, creeds and colours to make use of the capital that we have to invest, and they need the use of, to benefit the welfare of the tropics.

Summing up, therefore, I urge that steps be immediately taken to organise the supplies of native labour necessary for the development of the tropics in order to safeguard the lives and well-being of the natives on the one hand, and of the vast sums invested by the white races in tropical planting and other industries on the other. I ask this for the following reasons :—

1. That the results of such organisation would benefit both immediately, and in the future—

(*a*) The native labourer.
(*b*) Those who have invested money in tropical undertakings.
(*c*) The trade generally of the centre where the labourer emigrates to, as well as his own country on his return.

2. Every worker introduced into a newly-developed centre, confers a double benefit on others. He removes a unit in the competition in

† See "Tropical Life," June, 1911, page 112.

the labour market at his own centre, and increases the demand for manufactured and other goods, from the centre to which he migrates.

3. An assured supply of reliable labour would ensure a steady flow of capital to the tropics, whilst the absence of such a supply tends to place the capital already invested at a disadvantage, and even in some danger.

4. That, since the authorities in many parts of India are anxious to raise the status of the agricultural classes and to improve the methods of cultivating their land and preparing their crops, every encouragement and inducement should be held out to this class to go to other producing centres for a term of years, so as to learn improved methods, and by the wages they would earn there to obtain the capital necessary to give them a start in life, either in the country of their birth or adoption. Unless this is done the wished-for reforms will be indefinitely delayed in India, and the masses in her over-populated centres continue to live in a more or less chronic state of semi-starvation.

The CHAIRMAN: I am very glad for my own part that Mr. Smith did not abridge his paper, because we have all been immensely interested in it. The closing proposition of his paper, as to the relations of labour to capital, is one that appeals to all of us, but after listening to all that he has had to say, it still seems to me that to deal with tropical labour in any such way will entail enormous difficulties which to an inexperienced man like myself seem almost insurmountable. Anyone who has handled labour in this or in European countries, knows that to handle a given number of men of the labouring class is many times more difficult than to handle the same number of men of any other class, and I fancy something of the same kind will turn out to be the case in the tropics. There, as elsewhere, they like to act according to their own initiative. I hope we shall have a full discussion on this important point.

Dr. SCHIDROWITZ: I was very much interested in Mr. Smith's paper. What struck me more than anything in the East was the vast difference in the characteristics of the different types of labour employed there. You cannot handle a Tamil in the same way that you can a Chinaman, and you cannot handle a Chinaman in the same way as a Malay. They each have their individual characteristics. More than that, a Chinaman of one caste must be handled in an entirely different way to a Chinaman from another part. The Malay, who is the only inhabitant of the Malay Peninsula, is a peculiarly independent person. He likes to do individual labour, anything that leaves him his own individuality. One result of this is that the Malay will very rarely go in for routine work, such as that on a plantation. If you put him in a position where his individual characteristics have free play, he is all there; if you use him as a common labourer you can do nothing with him. The Tamil is very unlike the Malay in that respect, and the Chinaman is between the two. There is a vast gulf between the educated Chinaman, or the Chinese skilled labourer and the common Chinese coolie. The gulf is immense; it is far greater than the difference between the skilled labourer at home and the ordinary agricultural labourer. The Chinese skilled labourer is probably as skilful as any in the world. The Chinese coolie, on the other hand, is of a very low type, but you can practically teach him to do anything, and personally I feel that in time to come the plantations will have to rely very largely on Chinese labour of this type. The Tamil will do what he is told more or less efficiently, but as regards intelligence he does not compare either with the Malay

or the Chinaman. In looking at the labour problem these characteristics have to be borne in mind, and you cannot put into force any cut and dried plan to deal with every type of labour in the same way.

The Lecturer: Mr. Manders has given me permission to say that as many of those present would no doubt like to criticise my paper, he will be glad if they will send in any criticism or remarks which will be considered for publication. I was glad to hear Prof. Schidrowitz's remarks on the difference in the type of labour ,and that is why I confined my remarks to the Indian coolies, of whom I have had most experience. I have had a lot to do with Chinese, and they are splendid men to work, but they are much more expensive than the coolie, and therefore, from what I can gather, I look upon the Indian coolie as far as Malay and Ceylon are concerned, as a much more important item to consider than the Chinese.

The Chairman then made an announcement as to the papers to be read on the following day, and the Conference adjourned.

Official Measures against Adulteration of Wild Rubber.

By GUSTAVE VAN DEN KERKHOVE.

THIS PAPER WAS TAKEN AS READ.

Of all the rubber producing countries tropical Africa is the one which sends to the European markets the most varied kinds of rubbers, as to quality and appearance. This variety in the quality and appearance of the rubbers of African origin does not result from the diversity of the kind of plants treated, but only from the innumerable of processes used for gathering and coagulating the latex.

An examination of the hundreds of indigenous coagulation processes cannot be comprised within the present notice, but we will consider especially the adulteration of African rubbers and the means employed for preventing it. It is not without interest, in that respect, to look backward and to acknowledge the fact that the important question of the adulteration of African rubber is already an old one.

About in the year 1896 the adulteration of some kinds of Congo rubber, especially the red and black Kasaï, had assumed dangerous proportions. Out of ten twists, three were adulterated, *i.e.*, the ten balls forming each twist contained a certain quantity of palm-kernels and stones. It is easy to understand that such conditions resulted in numerous disappointments, in the shape of repeated complaints and refusals to accept the goods. It was absolutely necessary to bring that evil to a stop. The most severe instructions were sent to the producing places, and as well in Europe as in America the twists were examined with the greatest care.

These wise measures soon showed good results; in less than eight months the fraud could be considered as vanquished, the natives had learned that in the future no adulterated goods would go unnoticed.

The same state of things existed in French Guinea in 1897. The competition between the different foreign firms, especially in Conakry, had reached such a degree that the most inferior gums found a buyer at tremendous prices, and that qualities worth 4 and 5 francs a kilogram could only be sold in Europe at a rate considerably lower than the buying price. The natives had there a good opportunity for placing adulterated rubber. The evil was increasing in such a way that it attracted the attention of the authorities; and at the beginning of the year 1901 the French Government decided to prevent the export of the lower qualities of

rubber. The interdiction was carefully observed; no rubber left for Europe without having been submitted to a careful examination and, considering the tremendous volume of the rubber exports from French Guinea, it is easy to imagine the enormous amount of work required in the application of this unavoidable measure, for as one kilogram of rubber is often composed of about ten balls, all the said balls had to be handled separately, so that the authorities had to examine millions of pieces one by one.

Since that time, similar measures have been taken in many other African colonies.

It seems, however that since the enormous increase in rubber prices of March and April of 1910 the native gatherers of some African colonies have shown a marked tendency to go back to their former habits. In consideration of this tendency, the Belgian Government has quite recently issued a Royal Decree Article 3 of which reads as follows :—

" Whoever shall have offered for sale, sold, given in payment, or exported adulterated rubber will be liable to a penalty of three months' hard labour as a maximum, and a further penalty of maximum 500 francs, or one of said penalties only. The subject matter of the infringement shall be seized and confiscated."

Quite recently the Chambers of Commerce of Kayes and Bommako, in the French Soudan, asked the French Government to apply strictly the protective measures against adulterated rubber.

We can but comply with those good protective measures, but reservations have to be made as to their practice, or at least their interpretation, by officers who are certainly acting with good faith but are ignorant as to the technical conditions of rubber.

If we take, for instance, the Belgian decree, it is evidently judicious; but if put into the hands of agents who are not conversant with the different qualities of rubber, it will leave the door open for arbitrary action and even injustice. We are persuaded that the Belgian Government has foreseen this; but we consider it necessary, however, to review the different modes of adulterating rubber employed by natives and at the same time to call the special attention of the examiners of all the African colonies to the rubbers which have quite the appearance of fraud and are really not fraudulent, and also to the rubbers which are of good appearance although in reality dreadfully adulterated.

The foreign matters mostly contained in African rubber are the following :—

Water;
Sand, earth, stones;
Leaves, straw, bark, wood;
Palm-kernels with their rinds and other fruits with hard rinds;
Damaged textures;
Gum-like products without value.

Before all things, the examiners in charge of the application of the above-mentioned measures will have to show their perspicacity when examining rubber mixed with straw, leaves, bark or water, because if the proportion of these substances in the rubber is not more than 25 to 30% no penalty should be imposed for the rubber cannot fairly be regarded as adulterated.

The admixture to the rubber of stones, sand, earth, nuts of different kinds with their rind textures, must be considered as fraudulent, whatever the quantity may be. Perhaps we shall be asked:

"Why does an admixture of 15% bark not constitute an adulteration, while an admixture of 10% stones does?" Our answer is as follows: In certain gums the bark exerts a wholesome action, in that it absorbs moisture, while the stone can exert no action; on the other hand, a certain quantity of moisture in some kinds of rubbers exerts also a wholesome action. In other words, considering the two above given examples, it is of advantage for certain kinds of rubber to be entirely dry, and others are better preserved when moisture is retained. In that respect it is not unnecessary to recall what we said four years ago, at the Rubber Exhibition of Perydiana (Ceylon), *i.e.*, that the fine Para rubber of the Amazon, in spite of its 10 to 15% moisture, was, and would remain for a long time yet the best of rubbers. I believe that all my colleagues have taken the same view since.

One of the worst frauds consists in mixing to the latex mealy or even gummy substances, having the appearance of rubber and without the least commercial value. This is all the more dangerous because it requires a well-trained eye to notice it if the entire quantity is adulterated in this manner because the ball even sectioned has all the appearance of a rubber of good quality. In the case of such adulteration the officials should show themselves very severe in applying the regulations. A simple and practical manner of discovering the said fraud, without recurring to sectioning the balls, consists in dropping the ball on to the ground; if it does not rebound well, there is evidently adulteration by means of mealy or gummy products without any value.

French and Belgian Congo are the African colonies which are the richest as to rubber species, and it is also in the said countries that the greatest variety is encountered in the processes of gathering and coagulating the latex. Therefore, we have thought it of interest to give a comparative table of the principal kinds of rubber produced by the said countries, and we hope that the particulars given therein will be of some use.

In finishing this study, we may safely give the following advice to the rubber examining agents :—

Be energetic, but not rigorous, and always keep in mind what we have said above, *i.e.*, that a piece of crude rubber, even cut in two, may appear strongly adulterated although it is not; on the other hand, a rubber may have a first-class appearance and be nevertheless badly adulterated.

COMPARATIVE TABLE

OF AVERAGE OF LOSS IN WEIGHT, IN MANUFACTURING OF THE PRINCIPAL KINDS OF CONGO RUBBER.

(Belgian and French Congo, by GUSTAVE VAN DEN KERKHOVE.)

BELGIAN CONGO.

Country of Production.	Average of Loss in Weight in Manufacturing.	Mode of Coagulation.	Causes of Loss.	Distinctive Features.
Red Kasaï ..	7 to 12 per cent.	Natural heat ..	Bark	Twists ; amber-coloured ; translucent ; very nervous.
Black Kasaï ..	10 per cent.	Ebullition ..	Mineral matters ; moisture	Twists ; black, rapid oxydation ; little nervous.
Ruki	10 to 12 per cent.	C. A. Bossanga ..	Moisture	Balls ; white, pure ; very nervous.
Ikelemba	12 to 18 per cent.	C. A. Bossanga ..	Moisture and small proportion of vegetable matters	Balls ; white, pure ; very nervous.
Bussira	12 to 18 per cent.	C. A. Bossanga ..	Moisture and small proportion of vegetable matters	Balls ; white, rather pure ; very nervous.
Lopori	12 to 18 per cent.	C. A. Bossanga ..	Moisture and small proportion of vegetable matters	Balls ; white, rather pure ; very nervous.
Lomani	15 to 20 per cent.	Natural heat ; ebullition	Vegetable matters and a little moisture	Balls and Braces ; dark brown ; nervous.

COMPARATIVE TABLE of average of loss in weight, etc.—*Continued.*

Country of Production.	Average of Loss in Weight in Manufacturing.	Mode of Coagulation.	Causes of Loss.	Distinctive Features.
BELGIAN CONGO.				
Mongalla and Upper Congo	12 to 25 per cent.	Ebullition; natural heat; C. A. Bossanga	Moisture and vegetable and mineral matters	Great variety of shapes and features.
Lake Leopold ..	20 to 28 per cent.	Ebullition; natural heat; salt	Vegetable and mineral matters; moisture	Balls; dark-coloured; little nervous; rapid oxydation.
Aruwimi	25 to 30 per cent.	Ebullition; fermentation; salt	Vegetable matters and moisture and mineral matters	Balls; dirty grey; pretty nervous, but often fermented.
Djuma	25 to 30 per cent.	Piling; ebullition	Vegetable matters and moisture	Balls and Thimbles; dark brown, sometimes black; pretty nervous.
Piled red thimbles	30 to 50 per cent.	Piling	Vegetable and mineral matters	Cubes; reddy brown; nervous after refining.
FRENCH CONGO.				
Upper Sangha ..	14 to 18 per cent.	Natural heat; ebullition; C. A. Bossanga	Moisture; small proportion of vegetable and mineral matters	Cubes and Balls; dark-coloured; the cubes pretty nervous, the balls more.
Ekela Sangha ..	18 to 20 per cent.	Natural heat; ebullition; C. A. Bossanga; salted water	Moisture; small proportion of vegetable and mineral matters	Balls and occasionally Cubes; yellowish; rather nervous.

COMPARATIVE TABLE of average of loss in weight, etc.—*Continued.*

FRENCH CONGO.

Country of Production.	Average of Loss in Weight in Manufacturing.	Mode of Coagulation.	Causes of Loss.	Distinctive Features.
Kadei Sangha and N'Goko	18 to 20 per cent.	Natural heat; ebullition, and salted water	Moisture; small proportion of vegetable and mineral matters	Balls and occasionally Cubes; yellowish; rather nervous.
M'Poko	18 to 25 per cent.	Natural heat; settling with aqueous addition	Slight moisture; bark	Small and large Rolls; marmored red; nervous; careful coagulation.
Alima	20 to 25 per cent.	Natural heat; settling; salted water; fermentation	Moisture; vegetable and mineral matters	Balls; from white to dirty grey; mostly nervous; strong fermentation.
Oubanghi	18 to 25 per cent.	Natural heat; settling with aqueous addition	Slight moisture; bark	Small and large Rolls; marmored red; nervous; careful coagulation.
Likouèla	20 to 25 per cent.	Natural heat; settling; salted water; fermentation	Moisture; vegetable and mineral matters	Balls; marmored red and dirty grey; mostly nervous; grey balls often fermented.
Ibenga	22 to 28 per cent.	Salted water; fermentation; settling	Moisture; vegetable and mineral matters	Balls; marmored red and dirty grey; mostly nervous; grey balls often fermented.

Comparative Table of average of loss in weight, etc.—*Continued.*

FRENCH CONGO.

Country of Production.	Average of Loss in Weight in Manufacturing.	Mode of Coagulation.	Causes of Loss.	Distinctive Features.
Ogooué	22 to 30 per cent.	Settling with aqueous addition; salted water; fermentation	Considerable moisture; vegetable and mineral matters	Balls; dirty grey, occasionally marmored red; grey balls often fermented.
Ongomo	24 to 30 per cent.	Settling with aqueous addition; salted water; fermentation	Considerable moisture; vegetable and mineral matters	Balls; dirty grey; pretty nervous; often fermented.
Kouillou Niari ..	24 to 30 per cent.	Settling with aqueous addition; salted water; fermentation	Considerable moisture; vegetable and mineral matters	Balls; dark coloured, reddy and dirty grey; rather nervous.
Bata	24 to 30 per cent.	Salted water and occasionally other chemical reagents	Moisture; mineral matters	——
Batanga	24 to 30 per cent.	Salted water and occasionally other chemical reagents	Moisture; mineral matters	White, yellowish, dirty grey; often sticky; little nervous; tendency to oxydation.
Libreville	24 to 30 per cent.	Salted water and occasionally other chemical reagents	Moisture; mineral matters	——

As a comparison, the Para fine gives a loss of weight of 10 to 15 per cent. of volatile matters, according to the age of the rubber.
N.B.—Mostly of the above grades are from Vines.

The Maintenance of Health in Rubber Planting Districts.

By W. CARNEGIE BROWN, M.D.

Member of the Royal College of Physicians of London.

This was delivered as an evening lecture illustrated with lantern slides. Dr. Torrey presided.

The CHAIRMAN: In our previous sittings of the Conference we have dealt with the numerous ills to which rubber is subject, and subsequently we had something in the way of knowledge of trees and leaves. Now we come back to the human element, which we all ultimately fall back upon and depend upon, and by which we stand or fall. The lecturer of the evening is to speak to us of the hygienic conditions of maintenance of health in rubber planting regions of the tropics. I have great pleasure in introducing him to you.

Dr. BROWN said: Ladies and gentlemen, I propose to-night to address you on a subject of very great importance, viz., the climatic conditions and the maintenance of health in tropical settlements, and especially in the rubber planting districts of the East. As you all know, the development of the industry has been attended by a huge demand for native labour, and of recent years an enormous influx of coolies has taken place into territories which naturally offer remarkable facilities for the spread of tropical disease. Necessarily, also, the supervision of native labour on an estate requires the employment of a considerable staff of Europeans, and in response to this demand large numbers of young men have recently left this country to make their homes in the tropics, and to assist in various capacities in the production and marketing of rubber. Apart from the fact that the indigenous populations are deeply infected, many of these native labourers and their children, although they themselves show no signs of illness, harbour the germs of malaria and other parasitic disorders and are consequently a readily available source of contagion, of which the most frequent victims are the other immigrants and especially the highly susceptible new arrivals from Europe. In the circumstances, there is a little cause for surprise that serious outbreaks of tropical disease are not unusual, and it is only natural that the parents and relatives of young men who go out to the rubber districts should be deeply concerned as to the conditions of life there, and as to what chances a young man has of withstanding the effects of the climate. During the last two or three years no question

has been more frequently asked of me than "Is the climate really very deadly, and what prospects do you think my boy has of maintaining his health on a rubber estate?" Before going farther, it may be well to answer these queries. There is no doubt that most estates are naturally insalubrious, but the causes of tropical disease are now well known, and almost complete prevention is by no means difficult. The drainage and cultivation which are necessary for the successful production of rubber are powerful aids to sanitation, and on a well-managed estate there should be no epidemics, and very little serious illness. Intelligence and constant vigilance are required, but, given these essentials, the death rate should scarcely be higher than it is in Europe; and, on the understanding that he is careful about what he eats, and especially about what he drinks, and provided that he takes some precautions of which I will speak later on, there is practically no reason why an assistant should not be as healthy on a rubber estate in the tropics as if he were employed on a farm in Yorkshire. I base this confident statement, however, on the assumption that he is a picked man, and that when he goes to the tropics he is absolutely fit and well. Unless that is so, he had better stay at home; and for the benefit of any here who think of trying their fortune as rubber planters, I will indicate as briefly as possible the qualifications which are demanded of all candidates for tropical employment. His age should be about 21. A man may go out younger, but, of course, it is a matter of physical development. He should be normally and naturally developed and should have a good physique. It is not necessary for his physique to be too good, but his growth should be proportional to his age and other developments. Particularly he should be, not what is known a weedy individual, and on the other hand he should not be too fleshy. The big stout red-faced man does not do well. Of course, one must take all these points into consideration and also go into the family history of the candidate to see if there is any tendency to nervous disease or insanity, because the change of life in a hot country is generally very trying to the mental equilibrium. Very often I have seen young men who would have done well at home, permanently incapacitated in the tropics. There must, of course, be no tendency to alcoholism or to tubercule. All the organs must be sound, the heart especially, and a searching examination must be made on all these points.

The Climate and its Effects on Europeans.

For the successful production of plantation rubber, reliable and efficient supervision is necessary, and the assistance of a considerable staff of skilled Europeans is essential to the economical administration of a large estate. The recent development of the industry has, in consequence, created a keen demand for the services of capable and promising assistants, and during the last few years, there has been an enormous increase in the white population of the rubber planting districts. Almost by every steamer numbers of young men leave for the tropics, often to make their homes in places about which little is known but which are generally considered to be very unhealthy. Naturally, this is a cause of great anxiety to parents and relatives at home; and there is no question which is more frequently asked of those who are acquainted with the actual state of affairs than "What are the usual effects of the climate, and is there a reasonable prospect of being able to escape climatic disease?"

The answer is simple. In their natural state, most of the districts where rubber is grown are distinctly insalubrious; but the measures which are imperative for successful cultivation—especially drainage—at the same time rapidly improve the sanitary conditions, and the prospects of good health both for Europeans and natives depend almost entirely on their own prudence and on the intelligence and capacity of the estate administration. The sources of most tropical diseases are now well known, and if ordinary precautions are taken, the great majority of them are easily preventable. It may, indeed, be confidently stated that except in rare and special circumstances, the hygienic conditions of a well-managed plantation are entirely satisfactory, and the risk of disease should be little greater than on an English farm. On the other hand, disregard of simple precautions as to the supply of pure drinking water, the drainage of swamps, the proper disposal of sewage, and obedience to the elementary rules of cleanliness, is invariably a cause of serious illness, and not infrequently of irremediable disaster.

The Selection of Candidates.

Apart from the observance of these fundamental laws, however, it is of great importance—both to employer and employed—that none but those who are physically fit and sound should be engaged for service on a rubber estate. This is especially true of the European staff. The change in the conditions of life which transference from a cold to a hot climate entails is undoubtedly a very severe test of the strength of a constitution, and the strain is more acutely felt when the new arrival is engaged in the supervision of outdoor work, and is consequently much exposed to the tropical sun. As employers are naturally unwilling to submit to the serious inconvenience and loss which result from having to send men home who should never have been allowed to go to the tropics, they invariably insist on a strict medical examination, and it may be of interest to prospective applicants to know what are the physical qualifications which are generally demanded as a condition of engagement.

The candidate should be well developed, and although maturity is reached earlier in some cases than in others, he should not as a rule be less than 21 years of age. Physique is naturally of great importance. Big, full-blooded men, however, are by no means the best subjects for the tropics, whilst, on the other hand, undersized, weedy, and poorly nourished individuals almost invariably do badly. The development of bone and muscle should be normal, and proportionate to growth. Tendency to mental or nervous derangement, such as a family history of insanity or epilepsy, and predisposition to alcoholism, are, of course, absolute disqualifications. Tubercular trouble which has become quiescent is particularly apt to be roused into activity in a warm climate, and those who have consolidated patches in their lungs, enlarged glands, or other evidences of latent tubercle are well-advised not to attempt work in the tropics. Heart-strain is frequently found in athletic candidates who have overtaxed their strength, and is a condition which is very unfavourably influenced by tropical life. There is also in all warm countries exceptional liability to dysentery and other intestinal disorders, and the soundness of the digestive organs, including the teeth, ought to be assured. Every structure, in short, has to be separately investigated; and it is imperative that the functions of the kidneys should be thoroughly tested.

The Period of Acclimatisation.

After he has passed this somewhat trying ordeal and successfully entered on his duties on a rubber estate, the candidate has to exercise care in several directions, and, generally speaking, to "go slow." The first eighteen months or two years are the most trying period of tropical life, but recent arrivals are apt to forget that the exuberant activity which is innocuous and natural in cold climates is impossible in their new environment, and until they have been laid low by a sharp crisis of fever they seldom realise that violent exertion in a high atmospheric temperature has special dangers for new comers. Moderate exercise or ordinary outdoor work with suitable precautions are, on the other hand, beneficial. During acclimatisation, also, similar attacks of fever are frequently induced by almost any form of imprudence, over exposure to the direct rays of the sun, excess in eating or drinking, or severe fatigue; and the effects of specific infections such as Malaria and Dysentery are exceptionally severe.

But with a constitution adapted to the tropics and with ordinary care, these dangers should be easily overcome. The protection of the head by a sola topee, or thick, light and well ventilated sun hat, is of special importance. Not infrequently one meets men who assert that the tropical sun is harmless, and who wear nothing but ordinary head gear at all times of the day, but it is a very dangerous experiment to follow their example. Although it is true that a few individuals have an unusual power of resistance, immunity to the effects of the tropical sun is very rare in Europeans. Fatal results are not uncommon, and I have known several instances in which young men of great promise were reduced to a condition of permanent invalidism by attempting to do outdoor work without sun hats. On most estates also the atmospheric temperature varies considerably at different times of the day; and not infrequently, when sleepers are perspiring freely, it falls 15 or 20 degrees between midnight and dawn. In such circumstances the internal viscera are particularly liable to chill, and it is advisable to have some protection for the abdomen, such as is afforded by a woollen bandage or "cholera belt." In the low country, even the lightest blankets can seldom be used at bedtime, and a warm covering should always be available for use during the night. Immediately after exercise a woollen jersey or "sweater" should be worn; and most tropical residents have learned from unpleasant experience, that when the skin is acting freely it is unwise to indulge in a cold bath. The results of a chill which has been contracted through neglect of these precautions may, however, often be prevented by having a hot bath, going to bed, and taking five grains of calomel, followed by ten grains of aspirin, or in malarial cases, by ten grains of quinine.

General Sanitation.

After the period of probation is passed, the European assistant is sufficiently safeguarded by the measures of sanitation which are necessary for the maintenance of the general health, and without which it is impossible to expect that the labour force of an estate can be kept at anything approaching its normal strength. The appalling consequences of a severe outbreak of Cholera, Dysentery, Malaria, Beri-Beri or Ankylostomiasis are familiar to all planters; but as the methods by which these diseases are spread are now fully understood, they should

never become epidemic, and should indeed seldom give rise to much anxiety. For their prevention, however, the following measures are essential :

(1) The provision of a plentiful supply of pure drinking water.
(2) Permanent anti-malarial precautions.
(3) A suitable dietary.
(4) The effective sterilisation or destruction of sewage.
(5) General cleanliness, and the removal of all filth and rubbish.

The Provision of a Pure Water Supply.

In selecting and laying out an estate, no consideration is of greater moment than that of securing a reliable and readily available supply of good water. Infections of Cholera, Dysentery, and Typhoid Fever are almost invariably water-borne, and the first line of defence against epidemic outbreaks of these and a host of other intestinal disorders is to provide an abundance of wholesome drinking water. The facility with which this may be accomplished naturally varies with the position of the sites which are chosen for bungalows and coolie-lines ; and it is, of course, always advisable to take the supply from the source which is least liable to taint. Whenever possible, the drinking water of an estate should be collected from a jungle catchment area well above the level of houses, and it should then be brought by a pipe-line from a small protected reservoir direct to the houses. In most cases, however this is impracticable, and it is generally necessary to have recourse to wells or to river water as a source of supply.

Surface wells, that is to say shallow wells which are filled by the gravitation of surface and subsoil water, are always dangerous ; but if the impervious layers of the upper strata are pierced, a fairly reliable supply may be obtained from a deep well. Protection from pollution must, in the case of all wells, be secured by a waterproof parapet and by a concrete pavement sloped outward and extending for 12 or 15 feet round the opening. A river furnishes a much more questionable source of supply, for although water may be effectively purified by a comparatively short flow in a stream, river valleys in the tropics are generally so densely populated that freedom from pollution is rarely attainable. On rubber estates it is seldom necessary to store rain water ; but if it has to be collected the pipes should be fitted with a simple apparatus which is in general use in many parts of Australia. This appliance prevents the first water which falls on the roof from entering the storage tank, but after a certain amount of rain has fallen, a shoot turns automatically and water from a clean surface is secured.

In the tropics, indeed, with the possible exception of the first, all these natural sources of supply are unreliable ; and in thickly populated districts and on estates where a large force of native labour is employed, rivers and wells are specially open to objection. Practically, from whatever source water is derived contamination may take place ; and as heat is the only effective method of sterilisation, it should be made an invariable rule to *boil all drinking water*, and after boiling, to keep it as far as possible, sterile.

The sterilisation of water on a large scale has recently received careful attention, and it is now possible for a very moderate outlay to instal an appliance by which all the drinking water required on an estate may be effectively and economically sterilised. It is beyond the scope of this article to compare the merits of the various types of apparatus

supplied for this purpose, and it must suffice to say that there are several forms of water sterilisers now on the market which fully justify the claims made on their behalf that they have successfully attained these objects. In one pattern, which is in use on several estates in the Eastern tropics, the water to be purified first enters a heat interchanger provided with an inner cylinder or tube, where it is raised to a temperature of about 180° F. by the boiling water returning from the sterilising chamber. It then passes to the sterilising chamber, where it is brought to boiling point by additional heat which may be derived either from ordinary fuel, or from gas, oil, or the injection of live steam. The prohibitive cost of raising cold water to a temperature of 212° is thus ingeniously avoided, and—a point of importance in the tropics—the effluent water is at the same time cooled and aerated. Whatever form of apparatus is selected, the following points should be borne in mind :—It should be simple and easily worked ; all the parts should be readily accessible for examination and special cleansing ; and it should be able to deal with the water directly, that is to say, no preliminary preparation by chemicals or otherwise should be necessary. When there is much sediment—a frequent result of tropical rain—a filter may be employed as a preliminary measure ; but filtration is useless for sterilisation, and filters, dripstones, etc., may themselves prove a fresh source of contamination.

On no account should water be filtered *after it has been boiled*, and it should be taken for consumption direct from the storage tank. As a rule, sterilised water is perfectly free from taste ; and when an aerating steriliser is used, it is particularly clear, bright and sparkling.

Anti-malarial Measures.

Most of the rubber districts are malarial ; and if nothing were done to check the spread of the disease, the mortality in many cases would be so great that planting would be impossible. The prevalence of malaria is, however, by no means uniform. On many plantations the type of infection is mild ; and with the extension of cultivation and careful drainage, serious outbreaks of the disease tend to become very rare. But in other instances, especially on newly opened estates, the difficulties encountered in the repression of malaria are much greater ; and to overcome them, carefully organised operations are required. As mistakes in this particular branch of tropical sanitation increase rather than diminish the danger of infection and the cost of prevention, competent advice is always essential ; and when a large labour force is employed on a naturally insalubrious estate, the services of a doctor with special knowledge of anti-malarial measures are imperative.

It is now well known that the parasite of malaria is conveyed from infected to uninfected persons by mosquitoes. But it is not every variety of mosquito that can do so. The common mosquito in the Eastern tropics—*Culex*, whose shrill hum and irritating bite are so familiar—is harmless in this respect ; and practically only one family—the *Anophelines*—can carry the disease. There are, however, many species of anophelines, and several of them are fairly numerous in the rubber districts.

Now, it is evident from these facts that malaria may be prevented in several ways. In the first place, infection may be rendered impossible by destroying the mosquitoes. Old tropical residents are apt to jeer when they are told that this is practicable, but experience has shown

that it presents fewer difficulties than might have been anticipated. So far as malaria is concerned, only anophelines have to be considered; and as a rule they are readily recognised, their breeding places may be accurately located, and the distance they can fly is comparatively short. The following points of distinction should be noted:—In all the members of the anopheline family the proboscis is thick and projects directly in front of the head; unlike other mosquitoes, when at rest or biting, the axis of the body is always in a straight line; the wings

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

FIG. 1. ANOPHELINE MOSQUITO (MALARIAL). POSITION WHEN BITING OR RESTING. NATURAL SIZE.

FIG. 2. CULEX MOSQUITO (NON-MALARIAL). POSITION WHEN BITING OR RESTING. NATURAL SIZE.

FIG. 3. HEAD AND PROBOSCIS OF ANOPHELINE MOSQUITO (MAGNIFIED). THE PROBOSCIS APPEARS MUCH THICKER THAN IN NON-MALARIAL VARIETIES, AS THE PALPS ARE LONG.

FIG. 4. HEAD AND PROBOSCIS OF NON-MALARIAL MOSQUITO. NOTE THE SHORT PALPS.

FIG. 5. WING OF ANOPHELES MOSQUITO, MAGNIFIED, SHOWING SPOTS ON ANTERIOR EDGE.

are generally marked by three or four black spots, and the insect is almost noiseless on the wing. In malarial districts the eggs and larvæ of anophelines, both of which are also characteristic of the family, abound in small ponds, canals and weedy ditches; and it is in the drainage or sterilisation of these breeding grounds that the best method of

preventing malaria is to be found. They should be regularly cleaned out; and all swampy areas should be filled up or dried by giving exit to the stagnant water and by cutting off further supplies from the hills and rising grounds by contour drains. When complete drainage is impracticable, a small quantity of petroleum or kerosene ought to be sprinkled on the surface of the water once a week—the shortest time in which the insect can pass through its various phases.

To secure satisfactory results in the general sanitation of an estate, a few specially selected and specially paid coolies—say three per cent. of the labour force—ought to be permanently detailed to carry out these and other necessary measures under competent supervision. Their duties, apart from drainage and petrolage of swamps, canals, gutters, etc., should include the removal of broken bottles, tins and other rubbish where mosquitoes may breed, the emptying of unused baths, etc., the screening of necessary water barrels and cisterns, and the fumigation of dwellings, coolie-lines and stables. For the latter purpose green bamboo twigs burned on charcoal brasiers are generally sufficient, but sulphur candles may be necessary to kill the adult anophelines which often congregate in enormous numbers under the tiles and thatch of estate dwellings.

In a malarial district, infection is mainly derived from native children, who generally harbour large numbers of parasites although they show no obvious signs of illness. The question of how to deal with carriers—both child and adult—is a very difficult one, for their discovery and segregation are practically impossible. In many French colonies, where as in some of our own dependencies education is compulsory, excellent results have been obtained by the administration of quinine in the schools; and the action of the Indian Government in making quinine everywhere readily accessible has materially diminished the enormous toll of human life and human suffering which malaria formerly levied on the peasantry of that country. Used merely as a preventive of malaria on an estate, quinine is often of great value, but less reliance should be placed on its administration than on mosquito destruction. Both in prevention and in active treatment, quinine must be given regularly and continued *for six months after an attack*. If a patient under treatment stops taking quinine before that time because he has no more fever, he generally gets a relapse, and as he is infective to mosquitoes he is a source of danger to others.

A native protects himself at night by enveloping the whole of his body in a sleeping cloth, but for Europeans everywhere in the tropics the systematic use of mosquito curtains is imperative. Part of the verandah of every bungalow should also be made mosquito proof; and all hospitals, etc., where malarial patients are under treatment should be carefully screened.

The Disposal of Sewage.

On most estates insufficient attention has hitherto been paid to the destruction of night soil. Yet, when large numbers of labourers, and especially agricultural labourers, are living in close proximity to each other, the question becomes one of very great importance. Apart from cholera, dysentery and typhoid fever, numerous intestinal and parasitic disorders are propagated through neglect of this elementary sanitary precaution; and one of the latter—ankylostomiasis (otherwise known as tropical anæmia, hookworm disease, or miner's anæmia)—

has recently become very common in many of the rubber planting districts. In this serious and often fatal affection, the eggs of small intestinal worms which are frequently harboured by estate coolies, hatch out in enormous numbers in the earth where they are passed, and the minute snake-shaped larvæ are set free to look for fresh hosts. After wandering about in the muddy soil for some time they attach themselves to the feet and ankles of the barefooted field labourers, bore through the skin, and ultimately find their way to the intestines. The points at which they gain entrance become angry and inflamed, and form the eruption so frequently seen on the legs of estate coolies which is known as ground itch, and which often develops into chronic ulcers.

To arrest the spread of ankylostome infection it is necessary to prevent pollution of the soil, and when it has become tainted, to protect the feet of the workers. For the latter purpose, boots, unless they are watertight and reach well up the leg, are useless ; and an inexpensive substitute which is preferred by native labourers and is quite effective, is to smear the skin with a thin coating of tar and sand. At the same time it is imperative to destroy all estate sewage. This is usually effected by a system of pail latrines and a small furnace, and several varieties of moderately priced incinerators are now in use in asylums, gaols, hospitals, and on many estates in the tropics. Here, again, the simplest types of apparatus are the best, and a locally constructed but thoroughly efficient sewage destructor sufficient for a labour force of 400 men can generally be installed for a very moderate outlay. When in working order such an incinerator should be able to consume 500 lbs. of matter nightly at a cost of 2 cwt. of firewood and 40 lbs. of coir dust for admixture. Suitable estate rubbish, old gunny bags, etc., are generally available as additional aids to combustion, and two coolies at a daily wage of 65 rupee cents are sufficient for the whole of the work.

Estate Dietaries.

As a rule, managers are fully aware of the necessity of strict supervision of the food supplied to their labourers, and on most estates the diet is good, abundant and nutritious. But it must be remembered that unexpected danger may lurk in food which is apparently perfectly wholesome. It is more than probable, for instance, that the terribly fatal disease Beri-Beri is caused by a deterioration in the quality of rice—invisible and unknown—but which, in all likelihood, is set up by the outer layers of the grain being removed during milling. At all events, the disease chiefly affects Chinese, and does not occur in Tamils and other natives who use "cured" and freshly husked rice ; and it is known that, in the early stages at least, Beri-Beri can be arrested by substituting "cured" for white rice. The value of this discovery will be appreciated by everyone who is familiar with the labour problems of the Eastern tropics, and although the probability of a serious outbreak of Beri-Beri on a rubber estate is more remote than in the case of some other industries, its economic importance is enormous. Even as I write, I have received a letter from an employer of Chinese labour, who states that whereas a short time ago he lost three hundred out of every thousand coolies from Beri-Beri alone during the first year after they were imported, since he introduced freshly husked and "cured" rice his total death-rate from all causes is only thirty-five per mille.

A claim that Beri-Beri or any of the other protean maladies of the tropics can be entirely eradicated is, however, premature. Incessant

vigilance will always be necessary for their repression, and retribution will be the certain reward of apathy and negligence. But it is not too much to assert that the difficulties of estate sanitation have been immeasurably lightened by a knowledge of the causes of tropical diseases, and that proved methods of prevention, intelligently directed, are abundantly sufficient for their control.

The lecturer then proceeded to show a large number of lantern slides. First he showed a map of the Malay Peninsula, then the river and sea-frontages of Singapore, the prominent buildings, Hindoo Temple, coolies quarters and Malay house. Then he went on to show slides illustrating Penang, Malacca, and Kuala Lumpur.

The LECTURER: Before we proceed to show the slides of the plantations I should like to say something about sanitation. Singapore and these other places are not particularly healthy. There is a good deal of permanent insalubrity about them. It is only a thing of recent years, because in the early days Singapore was a very healthy place. Nearly 20 years ago the death rate was 31, from 1891 to 1901 it was 46, in 1902 it was 51, in 1908 it was 46·95, and in 1909 it was 38·41. Well, things have not been improving and last week I was reading that the deaths in Singapore included 103 from Malaria in the last week of May, 1911, and Malaria, you know, is a preventable disease. It is a very serious state of matters, and one that has not escaped the attention of the authorities. They have done a great deal, but one of the troubles is that an expert goes out and makes recommendations, then another goes out and makes other recommendations and generally speaking the later recommendations differ from those that have gone before. I should like to compare what is done by the authorities in these British possessions with what has been done by foreign authorities elsewhere. I will take first the City of Santos which at one time had a very unenviable reputation. Malaria was everywhere prevalent and people died on every hand. Yellow Jack grimly stalked the streets and every year carried off thousands. European labourers coming in from Italy and elsewhere picked up the disease in Santos and died on the estate. Even those who were supposed to be salted, died off rapidly during the epidemic and the death rate was 70 out of every 1,000 of the inhabitants every year, even among what was supposed to be the immune population. Well, in 1900, works were undertaken. They filled up hollows, straightened and cleaned streams, bricked surface drains, did plenty of disinfecting, cleaning and keeping up a flow in the channels, provided a pure water supply, rigorously enforced cleanliness, provided town cleansing brigades and prosecuted people who did not obey orders in this respect. Now, Malaria is practically unknown and ever since January, 1905, there has been no case of yellow fever. The death rate is now 22 per 1,000. Then there is a place called Sorocaba, where 2,322 of the 15,000 inhabitants had yellow fever in 1900. Works were undertaken in that year and since 1905 not a single case has been reported. Then you all know the story of Panama and how M. De Lesseps was defeated, not by the mountains, or the swamps, or the climate, but by the want of sanitation. The Americans took over the work when the death rate was 65·82 and working much in the same way as they did at Santos they reduced the death rate to 25 per 1,000. That is the position now in what is known as the Canal zone, where 250,000 labourers are working in great camps.

The lecturer then showed his slides illustrating Malaria, its causes and how to prevent it ; giving a description of the mosquitoes and specially illustrating ordinary methods of prevention and methods of preventing infection from children. A further list of slides dealt with Ankylos tomes and smallpox.

The CHAIRMAN : This lecture has been more or less a revelation to me in a certain way. Of course, we have all had certain vague ideas of sanitation and the way in which it differed in the tropics to what it did here. We know a little about Malaria, but it has never been borne in on me as it has to-night how insidiously all these things operate, and how impossible it is to meet them without skilled, resolute, and constant attention on the part of those whose duty it is to look after them.

Mr. HERBERT WRIGHT : In thanking Dr. Brown for his lecture, I rather feel sorry that the time is not sufficient to allow him to show us some of the most efficient preventatives of malaria, though he has, on broad lines, indicated what should be done. One point which particularly struck me is that the clean weeding of estates is one of the best methods probably of preventing malaria. On this he has thrown some new light. I have nothing more to say except that I regret that at this late hour we cannot hear any more about it.

The LECTURER : I could easily go on for some hours, but perhaps at some future rubber exhibition I may go more deeply into the subject. In the meantime, the sanitation of the estates is in good hands. The management thoroughly understand their business or the rubber could not be produced.

CHAPTER III.—Section I.

(I.) H. A. Wickham.—"The Para (*Hevea*) India-Rubber Tree in the East."

(II.) E. Lierke.—"The Manuring of Rubber Trees."

(III.) J. Mitchell.—"Some Diseases of *Hevea Brasiliensis*."

(IV.) W. R. Tromp de Haas.—"Tapping Experiments on *Hevea Brasiliensis*."

(V.) E. de Wildeman.—"African Rubber Vines: Their Cultivation and Working."

(VI.) Walter Fox.—"Notes on the Cultivation of Para Rubber."

(VII.) Paul Alexander.—"Some of the Constituents of *Parthenium Argentatum* (Gray), the Shrub from which comes the So-called 'Guayuale Rubber.'"

The Para (Hevea) India-Rubber Tree in the East.

By H. A. WICKHAM,

Late Commissioner for introduction of the Hevea (Para) Indian Rubber for the Government of India, Inspector of Forests, B.H., etc.

My object on this occasion is not the submitting of a paper, as such, on the *Hevea* tree in the East, but rather again to bring forward a few leading propositions in order that the time at our disposal be given to discussion—after all, generally the more important part in meetings of this sort. In doing so nothing, I trust, will be taken as in disparagement of Para rubber in the East. It has come to stay. It looks well and happy indeed in the new home; that surely is but added reason for securing for it best conditions for full development and for permanency.

First: In importance I submit to be (from what I have myself seen in the East, and elsewhere) that the *Hevea* tree has, and is still, being altogether too close-planted for a tree—a forest tree—of its natural order and habit.

Powers of growth must be arrested under such spacing, and the setting up a struggle for existence in consequence of deficient root-space constitutes a serious menace for the future.

It will, I think, be granted that one of the chief advantages of systematic plantation is to do away with, or at least to minimise, such struggle.

Of course, under natural conditions there *is* a great struggle with jungle and forest growth; but this is in a measure compensated, in that competitors belong to quite different orders botanically; and in that degree draw very largely from different food-constituents of the soil. Much material also is returned to the ground on which they stand in form of *humus* for future supply, whereas if a concentrated struggle be set up in plantation on denuded soil, it becomes internecine betwixt one and the same species, fighting for the same class of food-ingredients of the soil.

Thus, as I have always held from the beginning of this industry, a point to be considered is the ill-effect of, or from, over-strain, or shock, whereby the general vitality of the trees may become low-set and impaired by incidental and cumulative effect of treatment likely to render or to lay open, through lowered vitality, to inroads of morbid or fungoid growth. In all equatorial jungle-land and soils germs which are capable of inducing disease are, of course, generally and naturally present; but in the case of tree or plant normally healthy, they remain inocuous by reason of natural resisting power. If, however, the vitality of the subject

be lowered, either directly or locally by physical injury, or indirectly through a general lowering of vitality in the body, the existing power becomes impaired and remains so until the vital energy be restored.

Vitality being impaired, spores of morbid growth are enabled to enter, find lodgment, settle and multiply in the weakened tissues—if not overcome. As in our own community conditions of life, all breathe and take in the same germ-conveying air and foods, yet without material hurt or damage, unless and until they are enabled to obtain lodgment in a system weakened through accidental injury, over-strain, or other cause whereby natural vitality is lowered below par; so in the community conditions of plant life in plantation and estate.

Secondly: The system designated generally as "Clean Weeding."

Under it, the *humus* of the surface being first burnt off, what remains of the surface soil is exposed to the bake of the sun and the beat of the rains, and may be seen any day being carried bodily away in the drains to the nearest water-course—a loss never to be replaced.

The root system of such a tree as the *Hevea* so exposed *must* suffer.

On the other hand, systemised *mulch* would prevent this. It would induce conditions adapted to a tree of this class and habit. The *Hevea* loves to have its head in the sun and its feet and feeding-roots in a cool, free, covered soil.

It may be rightly said that maintenance of the *humus* contents of the soil is one of the most important factors in preserving its fertility.

I should like to quote what I look upon as being wise words bearing on this question by Dr. Ewart:—"Burning the surface destroys a few weeds, but also provides precisely those conditions which aid the spread of weeds which easily become troublesome . . . it makes for the impoverishment of virgin soils more rapidly without producing any commensurate increase in the crop to compensate loss of capital stored in plant food . . . it is the act of a spendthrift to burn away the capital accumulated for him by nature without effort in his part, and which might, if properly husbanded, have lasted his whole life.

"The use of fire to clear the ground in preparation for cultivation is common among primitive races who practice a more or less rudimentary kind of agriculture, but with scientific advance of agriculture, fire plays less and less part in its doings. Even in a garden the less the amount of 'rubbish' that is burnt instead of being rotted in, the less the amount of manure is needed to be carted in to keep up fertility. Exactly the same thing applies on a larger scale, and even greater extent to agriculture."

And, I would add, especially to forestry.

Thirdly: Incision *v.* Excision. I abide by the opinion that ultimately the former will be found to be the better method. It is all very well to pin faith on the result of a few years, but has it been seriously thought out? Can the *Hevea* tree reasonably be expected to sustain these renewals of bark-tissue, to be built up year in year out, for the term of its natural life? In this connection I am glad to see Mr. Kelway Bamber here, since I think that he will bear me out in my oft-expressed belief, that it is not at all necessary thus to pare away growing tissue.

I will now ask our Chairman to invite as full discussion as our time permit.

The CHAIRMAN: I am sure we have all been very much interested in Mr. Wickham's paper, and since Mr. Bamber has been mentioned, I will ask him to start the discussion.

Mr. Kelway Bamber: The three points raised by Mr. Wickham were, first, the close planting of trees. I quite agree with what he says that the ultimate state of the trees will be much better when widely planted, but we have to consider these points from the practical and financial point of view. So far it has paid better to plant fairly closely. There is no doubt, as he says, that the roots do intermingle in a very short period of time, but I do not think that with the present system of removing trees we need have any great fear about the removing of superfluous trees at a later stage and leaving roots that will cause injury to others. I was recently in the Malay States, and saw large rows of rubber trees being thinned out—trees being cut out without having been tapped. Personally, I think that is rather a waste. On other estates I have suggested pollarding the alternate row of trees at 9 or 10 ft., and tapping them for some distance. That has been done, with the result that they have got 900 lbs. per acre, and now the trees that were topped are ceasing to yield and are being removed. With regard to the loss of humus, I have been in favour of preserving the soil. It has always seemed to me absurd to burn off the forest and plant trees 20 by 30 or so, and long before the roots can reach the centre to remove every bit of growing jungle and allow the whole of the accumulation of ash to flow away. A good deal has been done in the way of growing green crops in semi-circles below the trees, and in growing smaller trees, cutting them frequently and utilising the leaves for mulching the surface, as Mr. Wickham suggested. There has been a lot of misunderstanding about the suggestion of keeping the soil covered. When one suggests that you should keep a cover of harmless plants that are nothing but graminæ, one does not mean that you should just let the plants grow up into jungle, but keep them under proper control and cut them several times in the year, which you can do in tropical climates, using the material for mulching under the rubber trees so as to build up a terrace. But what I find is, that if you suggest any of these things should be left, they are generally left a little too long, with the result that the plants seed and the whole ground becomes full of growth, which costs ultimately a large amount to remove. At the same time I must say that rubber kept fairly clean from the beginning does grow better than that which is absolutely allowed to run into jungle. With regard to the roots wanting moisture, I think there is not the slightest doubt, as I pointed out at the previous exhibition, that the whole flow of latex in the rubber trees depends on root pressure in the tree, and if, as is frequently the case, the surface soil has gone, the evaporation from the leaves is more rapid than absorption of moisture by the roots, and the flow of latex is found to be stopped in five or ten minutes, instead of running on for half an hour. This makes a considerable difference in the ultimate collection. As regards excision instead of incision, very little has been done with regard to incision at present. I started an experiment by which I obtained 1 lb. 3 ozs. per tree from a whole acre, as against ¾ lb. which was tapped by the ordinary method. At the same time we only had to tap the trees 70 days in the year against 180. The effect of this would be to entirely relieve the labour question to a great extent. The trees at the end of the first year's experiment looked in perfect health, and the experiment is being continued. As far as I can see, the flow of latex is greater than ever.

Mr. Fox: With reference to close planting in the East, I think I can possibly throw a little light on the subject. When the question of planting *Hevea* first came up, owing to the fall in the price of coffee

which started the growing of rubber in the first instance, the question was put, "How long will it be before we get any return?" We said, "About five years," and the reply was, "We cannot afford to waste five years. The coffee industry is practically ruinous, and if we do not get an immediate return it is no good." We suggested various catch crops, and amongst the suggestions was that the *Hevea* tree should be planted fairly closely with the idea that each alternate tree when it arrived at the tappable stage should be tapped as severely as possible and then removed, leaving room for the permanent crop. That explains to a great extent the reason for close planting, and refers more especially to the older estates. Some of the younger estates are being planted at a distance which I think more reasonable, and that is 20 by 20. I agree with Mr. Wickham as to clean weeding; I think it is somewhat of a fetish and that too much attention is paid to it. It requires stronger evidence than we have yet to justify it. I think the best method is to allow the growth to be left and dug in periodically. By doing that you return to the soil the sort of mulch it requires, and it is in the nature of manure. About the question of incision I do not know much, as my experience has been entirely with excision.

Sir DANIEL HARRISON: How do you tap?

Mr. KELWAY BAMBER: I do not split the bark, I make a fine channel to carry the latex, and use a pricker. There is a tree in the Ceylon Court tapped in that way which I shall be glad to show to anyone.

Mr. WYCHERLY: I think I shall have the whole room with me in congratulating Mr. Wickham on his return to civilisation once more in very good health and amidst the congratulations of everyone who having entered into the industry of *Hevea* growing has every reason to be satisfied with the result of his work. I should like to ask Mr. Wickham to tell us what is his ideal of planting *Hevea*, what distances he would advocate in the planting of new land in Ceylon or Malaya, Southern India, or German East Africa. I think that point would be very interesting to a large number of our friends from the Continent who have not seen the results, as some of us have, of the effect of the original planting in Ceylon and elsewhere. I do not think I am inaccurate in saying that the average distance at which *Hevea* has been planted on the best producing estates in Ceylon has not been more than 10 by 15 ft. I know several places where they are getting as much as 6 lbs. and 7 lbs. of rubber per tree from trees not more than eight years old where they stand 8 by 10. I have seen other plantations where they stand 8 by 8 with equally good results. In saying so much, I do not intend to advance a new theory as to very close planting, but I do venture to challenge, with all respect to our friend, the idea of wide planting which will not hold ground in some places. We have vast areas that are exposed to the whole fury of a monsoon, and I ask you whether it is possible to put a tender tree like the *Hevea*, standing 20 by 20 or 30 by 30, in isolated spots exposed to the monsoon in that way. If you do, there will be only one result, and that is absolute disaster. I had the opportunity of taking photographs of various plantations in the East, and particularly in Ceylon, and I must say the result on my mind was that I would leave wide planting severely alone. But it always resolves into the question of what is wide planting and what is close planting. I venture to ask you to study very carefully the pictures taken by Mr. Bamber, myself, and others. I have one of the original planting of *Hevea* introduced into Ceylon by Mr. Wickham. This was planted originally

6 by 6. A certain part was planted 8 by 8, and later 8 by 10. Well, I may tell you that two of these trees standing close together in the Heneratgoda Garden produced last year 110 lbs. of dry rubber, and the trees are 35 years old. They are equal to another 110 lbs. or 120 lbs. next year, and the average over the whole of the trees, even if they tapped them—which they do not—is equal to 30 lbs. or 40 lbs. per tree. I do not think any of us who have any interests at all in plantation rubber would have cause to quarrel with 40 lbs. per tree as an average in an acreage planted like that. I am speaking now, of course, from the financial point of view which interests, I think, the majority of our friends in this exhibition. But, of course, from the botanical point of view we all agree that if you can put two trees to the acre, why not put two ; if you can put four, why not put four? but when it comes to the question whether it will pay or not, I think we are all of one opinion that it will not, and cannot pay, to put your trees in Ceylon, or in the tropics—I will take the whole region of the tropics—less than 220 to the acre. Personally, I advocate 12 by 15 and on hill sides 12 by 10. I have seen results on hill sides which would tempt me to plant not wider than 10 by 10. Now I come to the question of incision *v.* excision, and I endorse every word said. I have studied it over and over again. I have pointed out to planters, and been abused for my pains, that in this question of excision there is, without the shadow of a doubt, the possibility of disaster to *Hevea* plantations such as followed the plantation of coffee. Unless something is done to modify the methods, I am afraid that in the next two or three years we shall be hearing of the beginning of such a disaster. I think a modification has been pointed out very well by Mr. Bamber. There you have a simple system of broaching the tree, without any question of putting it under the barber every morning. It takes you three years to get round your tree, and when, as Mr. Bamber tells us, you get by that simple way results such as he has stated, I think you have a solution to the question of excision *v.* incision. If you get these results you could halve your labour force in the space of two to three years.

Mr. WICKHAM, in reply, said : There are points in Mr. Bamber's remarks which are very encouraging to me. As to the practical financial part, I take it, from my view and experience, that that which is best for the *Hevea* tree, as a tree and as a growth, is the best financially and practically, too. With regard to clean weeding, I went through the ordinary course of the planter, the burning and clean weeding in former years ; but the result I have arrived at is to use the existing material. If you have heavy jungle, utilise your heavy jungle material, cut it up small and use it as a surface dressing to prevent the exposure of the surface and the loss of humus. Why should you consider it necessary in the East to bring in artificial cultivation when you have the single material ? After all, it is merely growing another kind of wood. Why not use the original material ? I have found it practicable and advantageous. If you have a well-protected surface and use this material as a deep mulch, you can retain all the conditions of forestry and of the natural tree and you have the best kind of cultivation going on. If you go for a clean scrape and take off the surface and expose it, you drive the earthworm away ; and all these things tell. With regard to the second speaker, he said that the origin of close planting was to get quick returns. From my experience—and it is rather a long one—I think you do not get a quicker return. It is certainly not larger. Half a chain is my limit ; that is 33 ft. or 40 trees to the acre. What

makes me marvel at planters in the East is that they would not think of putting in cocoa at those distances, and here in rubber you have a forest tree which requires far more area for feeding room. If you give it half a chain you give the tree a chance of natural development. You can produce three heavy primary branches which will sustain a wide-spreading heavy canopy. It will develop a big stem to carry that canopy. A remark was made by the same speaker as to wind exposure. In the first place, I should say it is very improper to plant *Hevea* in a wind-exposed locality. It should not be planted there at all. Its natural habitat is the doldrums, an atmosphere of calm, and it should not be exposed to the hurricane. In a case where it is subjected to wind exposure it would have a better chance if it was wide planted and had a deep root and a wide crop on the crown, than if it was close planted with the idea of later on thinning out the trees. The thing is unfathomable to me. Close planted they grow scaffold poles 100 ft. high, and if you cut out the trees, leaving one in four, they are likely to come down like ninepins, whereas if wide planting at first they would have a firm hold on the ground. I think Mr. Wycherly was most unhappy in his illustration of the trees in the Heneratgoda Gardens, which were originally close planted, because the tree which he referred to as giving such a good tapping had the advantage of being planted on a corner of a main carriage drive, so that it got its roots under that drive. The trees behind are dwarfs, and I think there could not be a better illustration of the point I have been making.

Mr. Wycherly: I spoke of the yield of two trees, not one.

Mr. Wickham: The other is broken off. What I feel seriously about is—though I have no particular axe to grind in this exhibition—that I feel very nervous; I feel there is a serious menace in the present situation. If you get interlaced roots you get the roots strangled and you have a risk of their dying back, and all sorts of fungi grow, as we heard this morning. I think in many cases these scientists mistake the effect for the cause, whereas, from what I have seen in the East quite recently, it is the very thing I should be inclined to expect, because these trees are becoming root-bound, and if the roots continue to bind in that way you may expect a dieback in the roots, and that will be a natural habitat for various fungi and growth of that sort. It is a very serious menace. I think these are the main points that have been raised, but if there is anything else I can reply to I shall be very pleased to do so.

The Manuring of Rubber Trees.

By E. LIERKE,

Within the past few years the interest in Rubber cultivation has been greatly increased, and where formerly the supply was mainly obtained from the virgin forests of Brazil and Africa, we now obtain large quantities from other sub-tropical areas as the Straits Settlements and Ceylon. At the commencement of the "rubber boom," when everyone's attention was attracted to the possibilities of making

money on rubber, those districts in the East where rubber trees could be grown were planted up, and in many cases this was done without any special regard to the particular needs and requirements of the tree. The present International Rubber Exhibition is an indication of the importance and stability of the rubber industry, and the Congress met

here to-day is an index to the interest taken in those questions which tend to put the cultivation of such an economic product on the same sound lines as any other product, such as wheat, sugar, or tobacco.

If we look for a moment at the figures quoted in the "India Rubber Journal" by Sir John Anderson, High Commissioner of the Federated Malay States, we find that in 1911 about 1,000,000 acres are already

under rubber cultivation. This gives an indication as to the rapidity with which plantations have been given over to rubber cultivation, and it is hardly conceivable that the selection of these plantations has always been conducted with care, because in the first place the best varieties, the most suitable conditions of the soil, and the plant food requirements have only quite recently been worked out, and are still being worked out in the laboratories and experimental stations. At

first those areas most suitable to the cultivation of rubber were planted up, but with the continuance of the "rubber boom" poorer soils were utilised, and to-day many of these plantations are showing ever-diminishing yields, since nothing has been done in the way of cultivation and manuring to restore the plant foods removed by the trees from the soil.

In selecting a plantation for rubber the first requirement is a good well-drained soil with a fairly high moisture content, the second point is the selection of seed from trees which have been proved to thrive under similar conditions of soil and climate, and which are really good latex

yielders; and the third point is that the trees should be planted in regular orchard form and cultivated and manured like other crops. In tropical agriculture we have already seen the good results obtained by the judicious application of suitable manures to such crops as sugar, tea, cocoa, and coffee, and these results have only been obtained on the large scale after carefully conducted experiments on trial plots so as to determine the best combination of the three essential plant foods—nitrogen, phosphoric acid and potash—to give not only an increase but a profitable increase over the unmanured or check plots. Magnesia and

lime may have a certain influence in the amount of latex and its output on rubber.

One must remember that the rubber-tree has not only to produce an increase in wood, but also to give a constant flow of latex, and this demands that in the soil a readily available supply of plant food should be found. A soil, however, may be so rich as to require no fertilizer at first, but if the trees do not make the desired progress, and if the latex does not flow fairly constantly, then the application of artificial manures should be considered. Rubber trees respond readily to good treatment and a few well-conducted experiments ought to be carried out in order to show the beneficial effect of manuring.

In arranging manuring experiments on rubber plantations, one may safely follow the experience obtained in manuring trials on fruit orchards. Here the application of manures has the effect of increasing the vigour of the trees and the development of the fruit is always earlier than on the unmanured plots. The sap of the fruit trees is analogous to the latex of the rubber-trees, and the early flow of the sap in the former case means an early development of leaves, blossoms, and fruit. Consequently it is not too much to infer that the application of manures to rubber-trees would give an increase in the flow of latex, and though manuring experiments in this direction are still in progress, the results up to date corroborate this view.

A common argument brought up against experimental work in rubber cultivation and manuring is that the supply may soon exceed the demand, as young plantations are yearly coming into consideration.

Up to the present, however, in spite of the increased production, there has been a steady advance in the price of the raw product and new uses for rubber are constantly being discovered. From the time that Priestley suggested the use of rubber for erasing pencil marks, followed by the process patented by Charles Macintosh for rendering wearing material waterproof, the uses of rubber have been greatly extended, and now perhaps the latest development is the idea to utilise it as a substitute for wood-paving. Even if the production of synthetic rubber be accomplished at prices to compete with the natural rubber, this should only serve as an incentive to the planters to strengthen their position by adopting scientific methods of cultivation and manuring. An analogy to this is provided in the case of sugar cane planters when their industry seemed to be hopelessly crippled by the competition of beet-sugar. A period of decline was certainly experienced, but with the adoption of modern methods of cultivation and of handling the cane they are now able to keep their own with this European industry.

Coming now to the question of manuring, much experimental work has still to be done, because the different varieties, such as *Castilloa*, *Hevea* and *Ceara* not only make different demands on the plant foods in the soil, but grow under widely different conditions of climate. This may be due to the fact that the plantations there are situated on poor soils, and the application of artificial manures containing nitrogen, phosphoric acid and potash in suitable proportions would in all probability increase not only the yield but would also improve the quality of the rubber. Nitrogenous manures must always be given with care since the

application of too much nitrogen tends to make the plants produce very quick growth, and this causes the trees to become very weak and tender. In this condition they are more liable to be broken down by the wind, and the soft growth is always less resistant to fungi diseases, whilst the latex usually shows on analysis a higher water content. The functions of potash and phosphoric acid are two-fold in that a greater development of the leaves and young shoots and an increase of the

circumference of the stems are obtained, whilst at the same time they play an important part in the formation of the latex.

Several planters have already carried out manuring experiments and the results so far have been very favourable; at any rate the influence of the manures has been indicated by an increase in the circumference of the stems. In October, 1906, an experiment was carried out

at the Deli-Moeda Plantation, Sumatra. At that time the trees (*Hevea*) were two years ten months old, and three plots of land were taken and differently treated with regard to manures. At the end of two years the circumferences of the trees were as follows:

Plot.	I. No Manure.	II. Completely Manured.	III. Manured without Potash.
Manuring per tree	—	2 lb. Pea nut Cake meal 12 oz. Double Superphosphate. 8 oz. Muriate of Potash	2 lb. Pea-nut Cake meal 12 oz. Double Superphosphate.
Average circumference of stems	9 inches	14 inches	12 inches

In the "Tropical Agriculturist," of September, 1909, appeared a report on a manurial experiment carried out by Mr. F. M. Elliot, Holland Road, Singapore.

Plot.	I. No Manure.	II. Complete Manure.	III. Manured without Potash.	IV. Manured with Ammonia only.
Manuring per tree	—	22 oz. Of a mixture of Ammonia Superphosphate and Bonemeal 10 oz. Muriate of Potash	22 oz. Of a mixture of Ammonia Superphosphate and Bonemeal	8 oz. Ammonia
Average circumference of stems January 31st 1909	$6\frac{3}{8}$ inches	$6\frac{1}{8}$ inches	$6\frac{3}{16}$ inches	5 inches
Average circumference of stems May 31st, 1909	$7\frac{5}{16}$ inches	$7\frac{7}{8}$ inches	7 inches	$6\frac{1}{4}$ inches
Average increase	$1\frac{9}{16}$ inches	$1\frac{3}{4}$ inches	$1\frac{3}{8}$ inches	$1\frac{1}{4}$ inches
Increase or decrease over unmanured	—	$\frac{3}{16}$ of an inch	— $\frac{3}{16}$ of an inch	— $\frac{5}{16}$ of an inch

Of particular interest is the experiment carried out on *Hevea*, by Mr. R. M. Eckert, Vincit, Ruanwello, Ceylon. By the use of a manurial mixture containing 6 per cent nitrogen, 5 per cent. phosphoric acid, and 5 per cent. potash, the trees grew very rapidly and the foliage was developed out of all proportion to the wood, with the result that the trees were broken down by the wind. A mixture containing 4·5 per cent. nitrogen, 4·5 per cent. phosphoric acid, and 15 per cent. potash produced, however, quite a different effect, the trees presented a vigorous appearance; the growth was uniform, and the trunks had a fine solid structure.

From these experiments it is evident that potash manures play as important a part in the fertilisation of rubber-trees as in fruit trees. The question as to the most suitable manures to be applied depends on so many factors such as the climate, the condition of the soil, the variety of rubber planted, and so on, that one must be on the spot to give any definite recommendations.

Taking into consideration the high freight rates on manures it is advisable to use the more concentrated potash salts such as muriate with 50 per cent., or sulphate of potash with over 90 per cent. potash. Then in regard to phosphatic and nitrogenous manures there is a fairly wide choice, and in view of the high prices of nitrogenous manures it seems to be the best policy to utilise local organic matter and waste refuse, such as damaged oil-cake, meat meals, and tankage as much as possible, and in this way to supply the soil not only with available nitrogen and a little phosphoric acid, but with humus which conserves the moisture—a point of special importance in tropical agriculture. These waste products are not so readily available, however, and an addition of sulphate of ammonia or nitrate of soda may be given to give the seedlings the initial start. Superphosphate can be usefully applied to soils in good condition, and where the soil is of a sandy nature and rather poor in lime and magnesia, then basic slag is to be preferred. In the young plantation also a leguminous crop may be grown between

the rows, and this when well mulched into the soil adds, in addition to the humus, nitrogen which the bacteria in the root nodules have taken from the atmosphere. Green manuring in this way is valuable, not only because of the addition of plant food to the soil, but also for the reason that the mechanical condition of the soil is greatly improved.

In conclusion, then, it is recommended that planters should experiment for themselves on the most approved scientific methods so as to find out the best treatment of their trees, and adopting Dean Swift's maxim to their special conditions, they should strive to produce, not exactly two rubber-trees where one formerly existed, for that would probably mean overcrowding, but to increase the quantity and to improve the quality of the latex, and so ensure a higher return per acre for their capital and labour.

The CHAIRMAN: The paper is now open for discussion.

Mr. HAMEL SMITH: I think it is a good thing that this paper has followed that by Mr. Wickham as the questions of distance in planting and of manuring go very closely together. It is no use planting your trees if you do not give them room to expand. Of course, the question of planting and manuring depends very much on local circumstances, but I think that on a rubber estate, as we found on a cocoa estate, they probably make their trees branch out with three main branches, so as to give a larger trunk and less height. In that case you will have to plant wider apart. If, therefore, you turn your trees to grow out with a much wider bark area, I think the lecturer will bear me out in saying that you will have to look to it that your land has much more potash in it. From what I understand of manures, potash is mainly instrumental in building up the framework of the tree. The present idea of growing tall trees will come to an end because of the smaller tapping area and the danger of breakage, when the industry finally settles down and gets beyond the experimental stage, and we shall gravitate toward shorter trees with a much greater bark area. The question of manuring will undoubtedly have to be considered both in building up the large frame of the trees and also increasing the rubber contents of the latex, because some of the trees yield more freely than others, as we see in the case of fruit. The question of roots, alluded to by Mr. Wickham, I also consider of great importance, because I have always noticed that the roots, the ground, and the leaf surface of the tree seem to come together. I do not know whether the idea is correct, but they generally maintain that if the tree is closely confined the dripping of the leaves on the ground is inclined to bring the roots up to the surface and, therefore, if it is correct that the amount of leaf surface of your tree affects the rubber yield of the bark, and also the more rapid reforming of the bark, as they maintain, then you not only want to build up your trunk and main branches, but also to nourish your roots and also the ground around the tree. It has often been noticed that when diseases of the leaves have attacked cocoa and rubber trees—I mention cocoa because it is an old industry and I have had most experience on it—if you give the trees an extra dose of manure at once the trees flush very much, as on the tea estates, and the tree throws off the disease much more successfully. In one of the experimental gardens they made the mistake of giving a second dose of manure and it was found that the trees threw off the disease much more successfully than the other trees did. Whereupon, they at once issued a special notice calling attention to the fact that by manuring the trees before they were actually attacked by the disease, when in a

neighbourhood where the disease is broken out, it lessened the chance of the trees taking the disease. Therefore, as we are making such good progress in the cultivation of rubber, it is very necessary that all sections of the trees should be carefully attended to and experiments made with manures required for each part of the tree—the root, the trunk, the bark, the latex and the leaves. (Applause.)

Mr. CLAYTON BEADLE: I should like to call attention to the possible utilisation of the Para seed, when the industry gets of sufficient importance, for manure in the same manner in which the cotton seed is used. I believe one estate at least is now collecting large quantities of seed, crushing it, removing the oil, and, of course, the cake which is highly nitrogenous is available either for the purpose of animal food or returning to the soil, as they do in cotton plantations. In these plantations the seed is largely used for the purpose of adding to the soil valuable manurial constituents, and I think a similar practice might be found to be of value on rubber estates.

The CHAIRMAN: I should like to ask Mr. Lierke what the effect is particularly of potash manuring on the actual productiveness of the trees. Of course, it is the general experience that a highly fertilised tree, or plant of any kind, in growing as rapidly as it does, is apt to produce a lean structure. You are apt to build up a soft, watery wood. One would, then, expect that the latex would be more watery and contain less rubber. I think most planters will be interested in the question of how manuring affects the productiveness of the tree.

Mr. SUTER: Following that query of the Chairman, I should also like to know if there is any likelihood of high manuring affecting the trees as regards pests and fungi. It is well known that plants that are richly manured do not withstand the climatic and pest conditions so well, and it will be interesting to know if any experiments have been carried out on that point.

Dr. LIERKE: There are no reliable results of carefully carried out experiments on rubber plantations. There are very few experiments introduced—or carried to a termination—on account of changes of managers of plantations. It is often the case that experiments are stopped in this way and we have received no further results of them. I have no experience in rubber growing, or in the requirements of rubber, but I may say that fruit trees give the highest result when widely planted and the trees are given sufficient area and light and air to grow healthy. A tree will not bring a good yield in the first year, but in later yields it will grow a heavy and healthy crop. When the tree has formed many strong branches with a good and sound foliage and with good sound fruit spores these are of great importance. I cannot express myself as well as I should like in English. We have found by experiment that manuring gives the best effect when the tree is healthy and well grown. If one of the plant foods is to be omitted, we find in our fruit experiments that the least effect is occasioned by the omission of nitrogen. Without nitrogen the tree grows fairly well and gives a good crop, but the fruit is not of so good a size. When we omit the potash we see a more dangerous effect on the leaves. The leaves are not the light green healthy colour, but become a more bluish green and if still left without this plant food the tree shows signs of potash starvation, and you get little brown spots and deformed leaves. With potash starvation we get a less productive tree and not such a sound foliage. In the second place comes phosphoric food. The same applies to the vine. Our vine growers have found that with manuring they get 2,300 marks per 1,000 litres, whereas without

manure they only receive 1,600 marks. I have heard with great interest Mr. Clayton Beadle's remark about the use of seed as manure and I should like to know if a sufficient quantity could be obtained as is the case in the cotton districts of America ?

Mr. Clayton Beadle : It will certainly be a large amount in time. There are some statistics, but I cannot say, because the labour has not been sufficient to collect the seeds.

Mr. Lierke : As to the effect of potash manure I can only repeat what I said about fruit manure. I do not believe the potash would make the latex more watery and contain less rubber ; but there have been no experiments and I shall say no more on that point. As to whether it would make them resist disease better, the experience is that a well-manured tree resists disease better, but the best manure cannot prevent attacks of any fungi or other diseases. The only thing definite is that it makes the tree more capable to resist disease.

Some Diseases of Hevea Brasiliensis.

By J. MITCHELL, A.R.C.Sc.(Lond.),

Mycologist to the Lanadron Rubber Estates, Ltd.

Introduction.—Probably no other matter in reference to the cultivation of *Hevea Brasiliensis* in Malaya has attracted so much attention during the last few years as that of " plant sanitation and disease." As you will realise, it is quite impossible for me (with the time at my disposal) to give more than the briefest of descriptions of the organisms which attack the trees. Each disease, if treated adequately, would be sufficient for a single lecture and there are several which are more or less injurious to *Hevea*. It is my intention, therefore, to confine myself to a brief outline of the principal characteristics of five of these diseases which have appeared in the Malay Peninsula.

Termes Geströi.—Taking first of all our insect pests there is only one which has caused any great anxiety, and that is *Termes Geströi*, or the " White Ant Pest." This was, at one time, regarded so seriously by the planting community of Malaya that a very substantial reward was offered for an effective method of exterminating the insect. The methods now being adopted are fortunately proving entirely successful and the " White Ant " has almost ceased to cause apprehension in the minds of those intimately acquainted with the cultivation.

Termes Geströi is not a common species in Malaya under normal conditions and the rapidity with which it multiplied when large tracts of land were opened up for the cultivation of *Hevea* was undoubtedly brought about by the balance of Nature being violently disturbed. During the last ten to fifteen years jungle has been felled and the ground planted with *Hevea* on an almost unprecedented scale, and this has naturally introduced a set of conditions previously unknown in the Peninsula, and such a change usually leads to results not altogether desirable. The species of plants at present forming the flora of the Peninsula have probably been members of the flora for centuries, and by a process of natural selection have come to have a fair degree of resistance to and immunity from diseases caused by insects and fungi native to the country. The sudden introduction, therefore, of a species of plant not a native of the country on so large a scale disturbs the balance, and an increase in otherwise unimportant members of the native insect fauna or fungus flora is abnormally stimulated. By a long process of selection

in the introduced cultivation it may come about that a much greater degree of resistance to and immunity from these pests will be developed. Proper adjustment will only be attained after a prolonged period of time and until then we must expect to be afflicted by these ills and must be ever on the watch to prevent them becoming too firmly established.

The workers are pale yellowish-white insects with a small head and an elongated, oval-shaped body. The first thoracic segment is enlarged and broader than the two thoracic segments following it. This insect is about one-quarter of an inch in length.

The soldier is a smaller insect than the worker, being about one-fifth of an inch in length and the body is rather yellower in colour, but this often varies according to the intestinal contents. The first thoracic segment is enlarged and of an orange-yellow colour, and the legs are longer and more powerful than those of the worker. There is an aperture in the head from which a white milky fluid is exuded when the insect is irritated. It must be remembered that there are other species of *Termes* associated with *Hevea*, but the above description of the worker and soldier will serve to distinguish *Gestroi* from the rest.

The insect builds subterranean nests, consisting of a variable number of connected chambers with perfectly smooth walls, and occurs most abundantly in damp, low-lying flat lands, and in swampy ravines. Its abundance in any particular soil, however, depends on the amount of timber on and below the surface of the ground, rather than on the nature of the soil, for it is the logs and stumps which contain the termitaria most frequently. It will be seen from this that the method of planting *Hevea* in land which is nothing less than a continuous network of logs and stumps is responsible for the prevalence of the insect and we shall see later that it is also responsible for the prevalence of the most serious disease attacking *Hevea* in Malaya, namely the root disease caused by the fungus *Fomes Semitostis*.

The depth to which the burrows of the insect goes varies according to the dampness of the soil, though they seldom penetrate to a greater depth than four feet, and in very damp soils they are to be found quite close to the surface. In wet weather, or soon after rains, the insects often come to the surface and build mud encasements round the base of the affected tree, and hence this is the time when they can be most easily discovered and dealt with. Among old trees which have been attacked for a considerable time without revealing any signs of the presence of the insect, we often find the nest within the hollowed-out trunk. It will be seen from this that evidences of attack are in many cases not shown until far advanced, so much so that in some cases the lateral roots and tap-root are entirely destroyed before we are aware of the fact. In other cases, however, small streams of latex may be seen exuding from small holes made by the insect.

Wherever a number of trees at one centre are affected it is fairly safe to assume that some log or stump on or below the surface of the ground is serving as a source of infection and in treating such a case it is necessary to locate this source before we can hope to successfully deal with the affected trees. If the affected trees occur singly and at widely separated points it usually means that a small number of the members of a larger community have become separated from the main nest, and we can, as a rule, completely destroy them before much further damage is done.

Fomes Semitostis.—Though the "White Ant Pest" had attracted a good deal of attention among planters previous to 1908 very little was

known in Malaya of the diseases caused by fungi. Since that time, however, they have come more and more into prominence, and one has but to read the reports of the various companies in Malaya to realise that this subject is receiving considerable attention.

The most important of these diseases at the present time is the root disease caused by the fungus *Fomes Semitostis*. Very few estates in Malaya can be said to be entirely free from it and many have already suffered considerable losses owing to its ravages.

The disease occurs most frequently among trees from one to four years of age, but is also prevalent in some nurseries and among trees up to ten years of age and over. In most cases individual trees here and there begin to show signs of ill-health, the leaves turn yellow, wither and fall prematurely. In other cases trees fall over while still in full leaf, but when the roots are examined they are seen to be quite rotten with the exception of one or two lateral roots which have served to supply sufficient water to the leaves to keep them fresh and green, but were unable to support the tree in the ground. Every transition from the former to the latter is to be observed so that no hard and fast rule as to outward symptoms can be framed.

In the neighbourhood of such trees others become attacked and die, so that in many cases quite large gaps are produced by the death of the trees in continually widening circles. The reason for the production of gaps in this way will be explained later. The disease is not confined to previously injured trees.

The physical character of the soil does not seem to have any special influence on the occurrence of the fungus, for I have observed it under every condition of soil. There can be little doubt, however, that loose friable soils such as sands and loams allow the fungus to spread more rapidly and many more trees are lost under such conditions.

The dead root is seen to be covered with a white mycelium usually in the form of cords of varying thickness, but which may form a continuous sheet of fungus tissue on the surface of the root. The mycelium on the roots of diseased plants taken from nurseries is often pure white and usually thin and sheet-like. When old the strands are usually of a yellowish colour, but sometimes are brown and even black.

The depth at which the fungus may be found is usually from 12 to 18 inches, but I have observed it on the roots of jungle stumps to a depth of over 3 feet. This fact has to be remembered when treating the diseased areas. From the strands on the tap-root and the lateral roots, branches are given off which spread through the soil and are assisted in their progress by any pieces of wood in their path. They are capable of spreading independently for a distance of from 3 to 6 inches through the soil. It will be seen from this that in course of time the threads must reach the lateral roots of the neighbouring trees and these become affected. It is this behaviour of the fungus threads which leads to the production of gaps in the plantation and these gaps must increase in extent and number the longer the fungus remains undisturbed. Every affected tree thus becomes a centre of infection for the neighbouring trees—a fact which emphasises the importance of locating and treating affected areas promptly and at an early stage. It is now becoming a general practice on estates to send round coolies to inspect each tree for signs of this disease. It is a great mistake to believe that the fungus will die out of its own accord, for after killing the tree it continues to live as a saprophyte on the dead tissues, and in course of time produces the fructifications with their innumerable spores.

Microscopic examination of diseased roots shows that the fungus thoroughly permeates the tissues of the wood. Sometimes the wood remains white, but is more often discoloured—yellow to brown. As the disease advances the elements of the wood become separated one from another so that the root is reduced to a soft mass, which can easily be powdered between the fingers. The whole of the tap-root is often completely destroyed and it is this destruction of the wood which causes the tree to become loose in the ground.

The fructifications are usually to be found on the decaying jungle stumps and on *Hevea* which has been dead for some time. All the stages of the development of the fructification have been worked out, but it will be sufficient in this place to describe the characters at maturity. At this stage it forms a semi-circular or kidney-shaped bracket attached by its edge to the dead stump or root. The upper surface is of a yellow-brown colour and is marked by a series of darker concentric lines. The under surface is of an orange or red-brown colour and on to this surface open innumerable small tubes along the sides of which the spores are developed. If the fructification be cut vertically it will be seen that the upper half is white, while the lower half (the spore-producing portion) is brown and this difference in colour forms one of the easiest means of identifying this fungus in the field, for it must be understood that scores of fungi produce white threads and brackets similar to those of *Fomes Semitostis.* When unchecked these brackets grow one above another and often form masses of great extent and thickness.

When the spores are ripe they are liberated and may be carried by wind or other agents to different parts of the estate. Should they retain their vitality (some of which must out of the enormous number produced) and alight on any damp rotting wood, they may germinate and produce the mycelium which we have seen spreads in all directions. The mycelium comes in contact with the roots of the trees and the attack on them begins and a new centre of infection is begun. It is the distribution of spores about an estate littered with decaying logs and stumps which leads to the infection of an estate at widely separated points, and one can picture the condition which must ensue in course of time if prompt and vigorous measures are not adopted in the beginning.

It is beyond all doubt that the method of planting *Hevea* immediately after the "burn-off" of the jungle is responsible for the widespread occurrence of this disease in the Malay Peninsula. The decaying logs and stumps are primarily responsible for the germination of the spores and the mycelium produced spreads on to the trees in the vicinity.

Hymenochæte Noxia.—Another root-disease prevalent on most estates but not causing much damage is that caused by the fungus *Hymenochæte Noxia.* This disease is better known under the term "Brown Thread Disease," which has reference to the fact that the fungus threads are of a tawny brown colour as opposed to the white or yellowish threads of *Fomes Semitostis.*

The characteristics of the mycelium and fructifications of this fungus are very different from those of *Fomes Semitostis* and it is very important that these differences be noted.

The outward symptoms presented by trees attacked by *Hymenochæte Noxia* are exactly those attending the penetration of any fungus into the tissues of the root, but in this case the trees do not become loose in the ground (an almost universal feature of trees attacked by *Fomes Semitostis*). Affected trees remain quite firmly fixed in the ground long after they have been completely defoliated and are quite dead. Again

the threads of this fungus move very slowly and one seldom finds more than two or three trees in one group attacked—they usually occur singly. It is fairly certain that a continuous path of dead or living wood must be present in the soil to allow the threads to make progress through the soil. When the tree is taken out the characteristics of the fungus become evident. The roots are seen to be encrusted with a mass of earth, sand and small stones, to a varying thickness, which the most careful washing for hours will not entirely remove. Beneath the covering of earth the mycelium forms a thin skin or sheet of tissue closely adherent to the surface of the bark, which it penetrates at numerous points. Occasionally it is possible to remove strips of mycelial tissue, when it will be seen to be about half a millimetre in thickness. In no case have I observed the characteristic rounded cords of *Fomes Semitostis.* In the earliest stages the mycelium is a mere cobweb of yellow or dirty white threads, but later it becomes thicker and assumes the tawny-brown colour which has led to the designation " Brown Thread Disease." In the final stages a black crust is developed externally, but beneath this crust the separate threads are of the usual brown colour.

The fructifications are to be observed as bright brown patches varying from half an inch to two or more inches in diameter. The *Hymenium* occurs on the upper surface of the fructification and the spores on outgrowths from the free surface—not along the sides of tubes, as in *Fomes Semitostis.* Between the outgrowths bearing spores there occur a large number of sterile cells projecting above the general level of the fructification. These are of a bright brown colour, and are narrowly conical in shape with sharply pointed ends. This is very characteristic of the fructification.

Fructifications are, however, very rarely produced, and consequently infection by means of spores must be a very rare occurrence.

Corticium Javanicum.—The above are the only root-diseases which have so far called for much attention in Malaya, though one or two others have occasionally made their appearance. Of stem diseases which have commanded attention we have *Corticium Javanicum* (Pink Disease) and " Die-back."

Corticium Javanicum is much better known in Java than in Malaya for up to the present estates in Malaya have not suffered much from it.

The disease commences in the forks of the trees or where several branches arise from the trunk at any point. The fungus forms, at first, a very fine cobweb-like growth on the bark, but the first sign one usually observes is the appearance of a pinkish spot, which gradually extends up and down the main stem and along the base of the branches. This pink sheet of fungus tissue may attack one side of the stem or branch or may completely encircle it. In the former case the disease is sometimes checked and a callus is developed from the edges of the healthy tissues surrounding the diseased area. Where, however, the fungus encircles the stem or branch the bark is killed and the stem ringed. At a certain stage in the development of the fungus the pink incrustation breaks up in a way resembling hieroglyphics, which has led to its being called the " writing fungus." As the fungus gets older the pink colour gradually disappears and it becomes white.

The fungus penetrates the bark and kills it, so that in an advanced stage of attack one can easily raise the bark from the wood beneath. The wood itself, however, seems to be but slightly affected and remains

a whitish or yellowish colour, quite different from what one sees in "Die-back," though a tree which is badly attacked may show symptoms resembling those of "Die-back."

The spores are developed on the outer surface of the sheet of fungus tissue and when ripe may be carried by the wind to any part of the estate. Should they alight in the forks of the trees and conditions as to moisture and temperature be suitable, they will germinate and again produce a mycelium capable of attacking and killing the bark.

"*Die-back.*"—A disease to which much attention is now being directed is that known under the common name of "Die-back," which has reference to the fact that the trees are to be observed dying from above downwards. "Die-back" is only a general term describing this condition of a tree, and it will readily be understood that it may be the result of many different causes, such as root-disease, impoverished and waterlogged soils, prolonged droughts, overtapping, occasionally by *Corticium Javanicum*, and sometimes in cases of "Canker."

For this reason one requires to be on the spot to determine from what cause the tree is dying, but here we can only deal with the fungus which has come to be associated particularly with this condition.

The affected trees are observed to die from the tip downwards, and it is usually the main shoot which is affected. The young leaves at the tip turn yellow and begin to droop and eventually the tip falls over and hangs limply. In course of time the affection extends downwards and each whorl of leaves lower and lower along the main stem droops and dies. When the fungus has reached the first whorl of branches these become affected and in turn begin to die. This is one of the characteristic features of "true die-back," for as the disease (which extends very quickly) passes down the stem, each whorl of branches becomes affected until eventually the whole of the crown of the tree is dead. If left unchecked death to the base of the tree ensues.

If we examine an advanced case we find that the bark is much discoloured and is cracked at repeated intervals and can be easily removed from the wood. In the cracks of the bark the fructifications of the fungus can be seen as small black pustules and these are filled with violet-brown spores, which, when liberated, make a sooty covering over the bark. This fungus has received many different names, but is most commonly known as *Diplodia sp.*, or *Botryodiplodia sp.* The reasons for the different nomenclature need not concern us here. When the bark is removed the wood is seen to be black in colour wherever the fungus has penetrated. The limits between diseased and healthy tissues are fairly sharply marked and one can usually tell by making an incision into the bark, and noting as to whether there is a flow of latex, the extent to which the fungus has passed down the tree. It must be remembered, however, that the fungus has seldom passed down the bark (cortex is a better term) as far as it has down the wood.

The fungus responsible for this disease is very common on numerous plants cultivated in the tropics and as a saprophyte on dead *Hevea*. It is for this reason especially that care is required to keep an estate in a highly sanitary condition. Dead branches, dead and dying trees, and accumulations of litter under the trees are a serious menace to the health of the estate and the clearing up and burning of these should become a regular part of the estate work.

It is not possible in the time at my disposal to deal with all the diseases which are claiming our attention, but those mentioned are the principal ones we have at present to cope with in Malaya.

So far I have made no direct reference to the treatment of these diseases. I have adopted this course because my experience has repeatedly taught me that only by practical demonstration in the field can the treatment of diseases be adequately and successfully taught. One has carefully to study the various conditions before recommending any procedure, even for the treatment of the same disease, and I have frequently observed in different parts of Malaya considerable waste of money, labour, and time (a most important factor when dealing with diseases which spread rapidly) owing to the following of advised methods which under some conditions are admirably suitable but under the prevailing conditions were unsuitable.

The symptoms of disease and the characteristics of the fungi described above vary within certain limits, but for all practical purposes the description given would suffice to guide the planter to a correct diagnosis of the case under consideration. The treatment of each disease, however, can only be *safely* advised when one knows the existing conditions intimately. One cannot follow hard and fast rules, and there are no cut and dried methods which will suffice for all cases. That is to say, and I wish to lay special emphasis upon this point, advice on these matters cannot be given from a distance but only by those in close and constant touch with the cultivation and after each case has been closely studied in all its bearings.

There are numerous other matters connected with plant sanitation which I would have liked to touch upon, but I considered it would be more profitable to deal somewhat fully with the principal diseases we meet with than to give you a mere smattering of all the matters that have to be contended with in the successful cultivation of *Hevea Brasiliensis*.

The CHAIRMAN : We have just listened to an extremely interesting paper, and it is now open for discussion.

Dr. TROMP DE HAAS : With regard to *Fomes*, I have often been in the jungle and found logs of dead wood covered with it ; how is it possible that fungus does not destroy the whole jungle ?

Mr. MITCHELL : In answer to that, the fungus specialises to some extent and only attacks certain trees. In a jungle you get a certain type of plant belonging to a definite order surrounded by plants of different orders, some of them far removed from each other. Therefore if one is attacked it is unable to convey the fungus to the distant trees, whereas in a Para Rubber Plantation they are all the same kind of trees, and the infection passes from one to the other. It is for that reason so much has been said about jungle belts, the idea of jungle belts being that if you have a disease on one side it comes in contact with plants of a different order, species, genera, and so forth, and cannot penetrate through to other trees of the same kind. It is for this reason you do not get a jungle devastated in the same way you do a plantation.

Mr. CLAYTON BEADLE : I should like to ask Mr. Mitchell whether tapping in moderation reduces the vital function and renders the trees more liable to attack.

Mr. MITCHELL : That is a deep question and would involve a good deal of careful study and experiment. I think there is very little doubt that fungi will undoubtedly attack trees that have their vitality reduced, and I think there is no doubt that tapping does modify the tree to a very

great extent. If a tree is vigorously tapped for a considerable time the vitality of the tree is reduced, and it would be more liable to contract diseases. So far as I know, *Fomes* will attack a healthy tree just as readily as one not in health.

Mr. Clayton Beadle: Two other questions: Whether at certain ages the tree is more susceptible, and also—which appears to be a very important question—during the period of the disease is the flow of latex very much affected?

Mr. Mitchell: As to whether age makes a tree more susceptible, trees are very much like animals in that respect, and at certain periods in their life are more susceptible to certain diseases. Certain diseases attack young plants and others attack old ones; consequently each year makes the tree perhaps immune to certain diseases but more susceptible to other diseases; so that as a general proposition there is really nothing in it. There is no saying that a young tree is more susceptible than an old one; you can only say that it is more susceptible to certain diseases. As regards the flow of latex, in the case of white ants the tree can almost be at its last stage and still flow very freely. As a matter of fact, a few years ago an exceptional flow of latex used to make us suspicious that the tree had white ants. It seemed that the ants stimulated the tree to an exceptional flow. In the case of *Fomes* I do not think it affects the tree until at the last. In the case of *Hymeno* the tree becomes defoliated, and in canker you can often tell when a tree has the disease by testing it on the tapping surface, which yields latex. It is only in the last stages, just before death, that the tree ceases to yield.

Mr. Richardson: I should like to ask if these diseases cannot be traced to soft wood stumps in the clearings? I have had some experience, and have generally found that it appears mostly in trees six or eight years old. In my experience, wherever I have seen a patch of it I trench it with a deep trench around and apply quicklime and also remove any trees that show signs of dying.

Mr. Mitchell: As to whether one stump seems to be more likely to have this fungus than another I do not think much can be said. From time to time records of the stumps on which it was found have been taken, and it was found that the number gradually increased. At first eight stumps were put down as specially affected, but as time went on the number increased to 15. I have found it on the softest stumps on the clearing and on the hardest. One knows, for instance, the hardness of bamboo. This seems a very inhospitable growth for any fungus, but I have found it on bamboo stumps and palms, so that it does not seem that the softness or hardness of the wood makes much difference, though I should expect it to prefer soft wood to hard. Whether it would take a certain length of time to decay before it would affect others is doubtful, because I have found *Fomes* very common in a clearing not more than six months old, almost immediately after the burn, and, of course, it occurs right on from that time onwards. As to the method of treatment, your treatment is certainly all right on a small scale if you have only a tree here and there affected, but if you take an area of 50 acres and find a tree here and there, you would have to trench the whole place. It all depends on the extent of the trouble. On a small scale, trenching will certainly stop it, provided you take out all the stumps near or in the area enclosed, and, of course, one must be careful not to leave any exposed wood in the drainage, or it will start new centres.

A question was asked as to whether the fungus would yield to complete sanitary measures.

Mr. Mitchell: As far as my examination goes it seems to me to be entirely saprophytic. It does not attack *Hevea* directly but requires dead wood of some kind before the spore can germinate, so it is from dead wood that the fungus spreads. If the estate is cleared of dead wood at the commencement there would be no fear of *Fomes*.

Mr. Suter: I should like to ask if there are certain periods of the year in which the spores germinate more freely?

Mr. Mitchell: As far as I know it will not matter in the tropics what period of the year it is, because the conditions are practically the same—the same temperature and the same kind of moisture. I have not had any experience beyond the Malay Peninsula, but it is quite possible, in case of countries where you get a dry season alternating with wet, that in the dry season the fungus would move more slowly; its vitality would not be so great; and that it would grow more quickly in a wet season.

Mr. Suter: Does close planting affect it?

Mr. Mitchell: Closely planted trees will be far more likely to be troubled, because it is a question of proximity to the affected tree. We do not know at the present time how many years it takes for the roots to intermingle, but it is very likely that in 15 by 15 ft. you get the roots intermingling freely, therefore from the third year the whole of the trees will be susceptible. But in the case of wider planting it will take longer time.

Mr. Petch: I do not think I have much to add to what Mr. Mitchell has said, but there are one or two points I should like to refer to. *Fomes* will not attack tea. In Ceylon we find *Fomes* undoubtedly grows on hard wood trees, and probably the reason why it grows faster when it gets to *Hevea* is that *Hevea* is softer. Mr. Mitchell mentioned bamboo and palms. I have seen a record to that effect from Malaya, but I think there is a mistake here between two different kinds of fungi. Some months ago a gentleman from America brought me two specimens and asked me if I saw any difference between the two. They were absolutely the same, but they were dried specimens. When you get the fresh specimens it is easy to distinguish between *Fomes Semitostis* and *Fomes Polyporus Zonalis*. As far as we know, *Fomes* does not grow on palms. With regard to the brown root disease we generally identify it by the fact that the root looks as though you had glued it all over and stuck it in the soil. It looks like a lot of stone and sand cemented on the roots, so that there is no difficulty in diagnosis. Canker, apparently, is not much thought of in Malay, but it is one of the serious diseases in another part of the world, especially where they grow cocoa. We have proved that canker of *Hevea* is exactly the same—the fungus of the canker is exactly the same in *Hevea* as the canker of cocoa. If you are growing cocoa and *Hevea* together your cocoa pods are furnishing fungus which attacks the *Hevea*. We have plenty of demonstration of that on estates interplanted with cocoa. That has led some planters to take out the cocoa, but you must thoroughly uproot it because where the stumps have been left in you get brown root disease starting from the cocoa stumps. Planters get alarmed about the diseases of rubber. In 1906 I drew up a list of fungi liable to attack rubber, and since that time there has been only one addition to the list. We have practically

no new parasite on *Hevea*. We have plenty of names. We have very many more names of fungi than we have fungi—that is the difficulty. That state of affairs is due to the fact that people take up a fungus in the tropics and send it home to Europe to get an identification. It is quite impossible to identify fungi from dried specimens sent home, and it is impossible to give an accurate account of a disease from specimens sent from the tropics, two or three weeks in the post, to England, Germany or France. The work must be done on the spot; it is perfectly hopeless to try and do it anywhere else. Tropical mychology and identification is in a chaos through specimens being sent home for identification. What is in a name? *Fomes Semitostis* in any other name would be just as dangerous. But the point is that by sending home dried specimens the same disease gets a lot of different names, and so it is made to appear that there are more diseases than there really are. Someone thinks he discovers a new fungus and it is brought out as a new disease, whereas it is only an old one. I could give many examples. A few years ago we had a fungus attacking *Hevea*, a root disease, one of the *Urudineæ*. It was one of those *Urudineæ* which did for coffee. A report was prepared upon it, and if that report had been understood by the planters who found it in rubber you would have an end of the rubber planting altogether, because it would have been thought that the rubber would have been killed like the coffee; but the fungus was not *Urudineæ* at all, it was ordinary mould which did not do any damage. Then take the case of the pink disease, *Corticium Calceum*: you can get in Epping Forest. If it had been given under its proper name of *Corticium Javanicum* it would have created a ferment. There was the result of a six years' investigation ready to hand for the Malay planter. It had been investigated under that name, but by being reported under the other name the Malay planter was cut off from that source of information. Then, again, you have the *Diplodia Rapax*. We had a fright over this. This was a new name for a fungus we had known on rubber in Ceylon for five years, and which had been known all over the world on cocoa for 15 years. But within twelve months it created a new scare with a new name—*Eutypa Caulivora*. This was first unearthed in Ceylon by Thwaites between 1860 and 1870. We have known it there for 40 years, and as far as I know it was saprophytic and we had never known it attacking anything else. Its name is not *Eutypa*. It is another instance of a well-known tropical fungus being put down under a new name and brought out with a new disease. Then *Irpex Flava*, one of the commonest in the tropics is also put down as a new disease. I could go on for the next two days, but there is no necessity to give any more examples. It is impossible to get accurate work done as regards the identification of fungi by sending specimens out of the tropics.

Mr. MITCHELL: I should like to say how much I agree with what Mr. Petch has said as to the name of fungi. We should appreciate a system whereby we could get at a correct identification. There are so many instances of different names for the same thing. For instance, the "diver fungus" has something like 12 names. It would be a good thing if there could be some central station in the tropics where this identification could be carried out.

Tapping Experiments on Hevea Brasiliensis.

By DR. W. R. TROMP DE HAAS.

These experiments have been made with the purpose of giving an answer to the following questions :—

1. How much bark can we safely remove in the tapping operations during the year?
2. How do the "every day" and "alternate day" systems compare?

The experiments were made with trees planted in 1904 and 1905 in the experimental garden of the Agricultural Chemical Laboratory of Buitenzorg.

Only those trees were tapped which had a circumference of at least 45 cm. (18 inches) three feet above the soil.

The following systems of tapping were tried :—

1. The cuts are made on two opposite quarter sections of the trunk, two cuts being made in each section. The distance between the two cuts is 30 cm. (1 ft.), and the trees are tapped every other day.
2. Same section, only the trees are tapped every day, and there is only one cut.
3. Cuts made on a section representing one-third the convex surface of the trunk. Two V-cuts are made, the distance between them being 30 cm. Trees tapped every other day.
4. Same section, but only one V-cut. Trees tapped every day.
5. Same section; two single cuts, 30 cm. apart. Tapped every other day.
6. Same section, but only one single cut. Tapped every day.
7. Section representing quarter the convex surface; two single cuts. Tapped every other day.
8. Same section; only one single cut. Tapped every day.

Sixty trees were taken for each experiment, except in experiment No. 4, when 66 trees were taken.

In order to be independent of the number of trees and the differences in circumference, the results have been based on one square metre of the tapping surface.

The total tapping surface in each group of 60 trees was as follows :—

1	19·43 square metres.
2	21·37 ,, ,,
3	18·40 ,, ,,
4	18·11 ,, ,,
5	17·40 ,, ,,
6	18·24 ,, ,,
7	17·20 ,, ,,
8	17·90 ,, ,,

The experiments were begun in February of this year, but not until March were the coolies sufficiently well trained to do proper work. The

total quantity of rubber collected in March from the eight different groups were as follows :—

1 ...... 3291 qr.	5 ...... 2365 qr.
2 ...... 5545 ,,	6 ...... 4436 ,,
3 ...... 3207 ,,	7 ...... 2598 ,,
4 ...... 4685 ,,	8 ...... 3304 ,,

Or, calculated on one sq. metre of tapping surface :—

1 ...... 169·4 gr.	5 ...... 136·0 gr.
2 ...... 259·5 ,,	6 ...... 243·2 ,,
3 ...... 174·3 ,,	7 ...... 151 ,,
4 ...... 258·7 ,,	8 ...... 184·6 ,,

In case of each of the four sections employed I have calculated the ratio between the quantity of rubber obtained in every day tapping and that obtained by alternate day tappings. The results are as follows :—

1 : 2 = 1 : 1·532
3 : 4 = 1 : 1·484
5 : 6 = 1 : 1·790
7 : 8 = 1 : 1·222

Taking into consideration the short time during which the experiments have been carried out, one may conclude from the above figures that a larger quantity of rubber is collected by every day tapping. Before we can draw definite conclusions the experiments must be continued for a much longer period.

The CHAIRMAN : The paper is now open for discussion.

Mr. PETCH : The results which have been given us by Dr. Tromp de Haas practically agree with results reached by Wright in 1906, after experiments which were carried on for over a year, and also with those of Bamber and Lock, which have now been carried on for over two years. If you can tap some trees every day and tap others every other day for the same length of time, of course you get more rubber in the every day tapping, but it does not follow that every day tapping is the best. In tapping every other day you get more rubber per tapping and more rubber per day, but you do not get twice as much a day. At the end of the year the daily tapping shows up with the greatest amount. If you are tapping on the four years system then with daily tapping you may complete the whole of your bark in two years, and then, according to the rule, you would have to give it a rest for the other two years, I suppose. I do not know that anyone has ever done it. But on the four years system with alternate day tapping you would be able to tap throughout the whole of the four years ; therefore at the end of the four years you would have more rubber by your alternate day tapping. It all depends on how long it takes you to complete one cycle of tapping. That is completely round the tree, using up every bit of bark. The lecturer seems to have got over that difficulty by giving twice the area of bark for his daily tappings than for the alternate day tapping. There are two cuts for the alternate day tapping and only one cut for the daily tapping. There is a question about the number of cuts on the tree which has never been properly attacked, I think. Most planters say, " Well, we can cut off so many cuts to the inch, say 20 to the inch, and we want to cut through the whole of one strip of bark on one side in the year ; therefore we put the cuts about 12 inches apart and so put about six cuts on the lowest 6 ft." That seems to me to be beginning at the wrong end. No one has yet deter-

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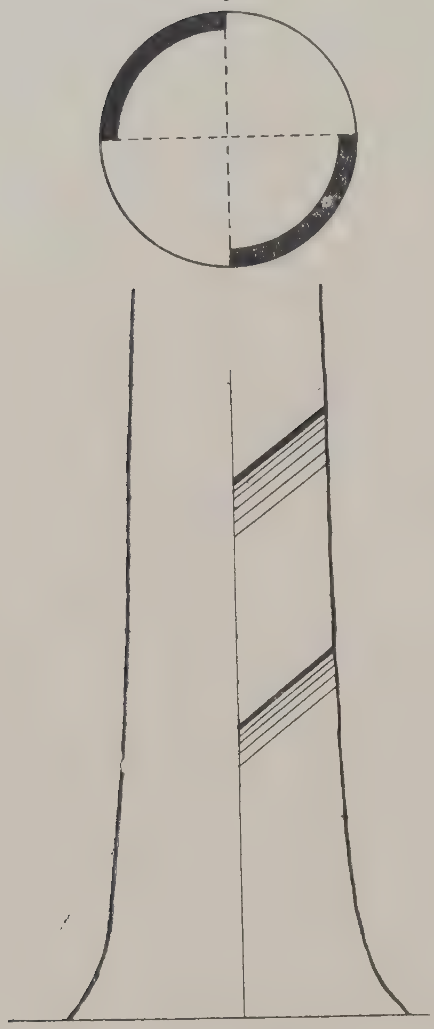

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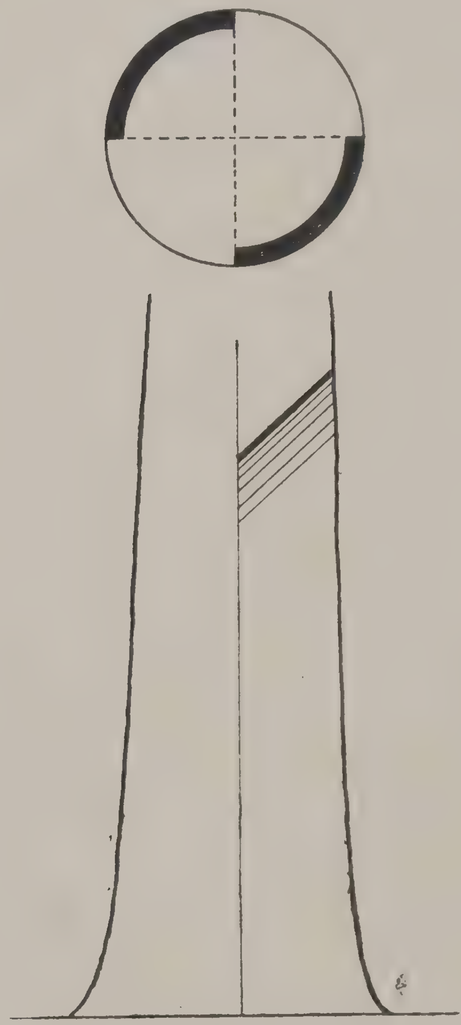

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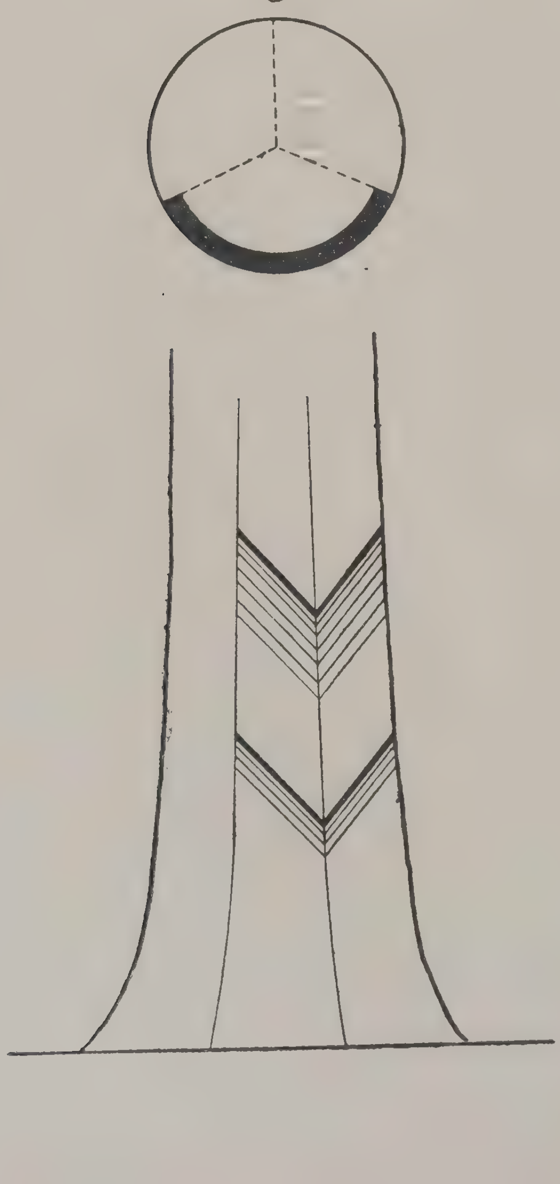

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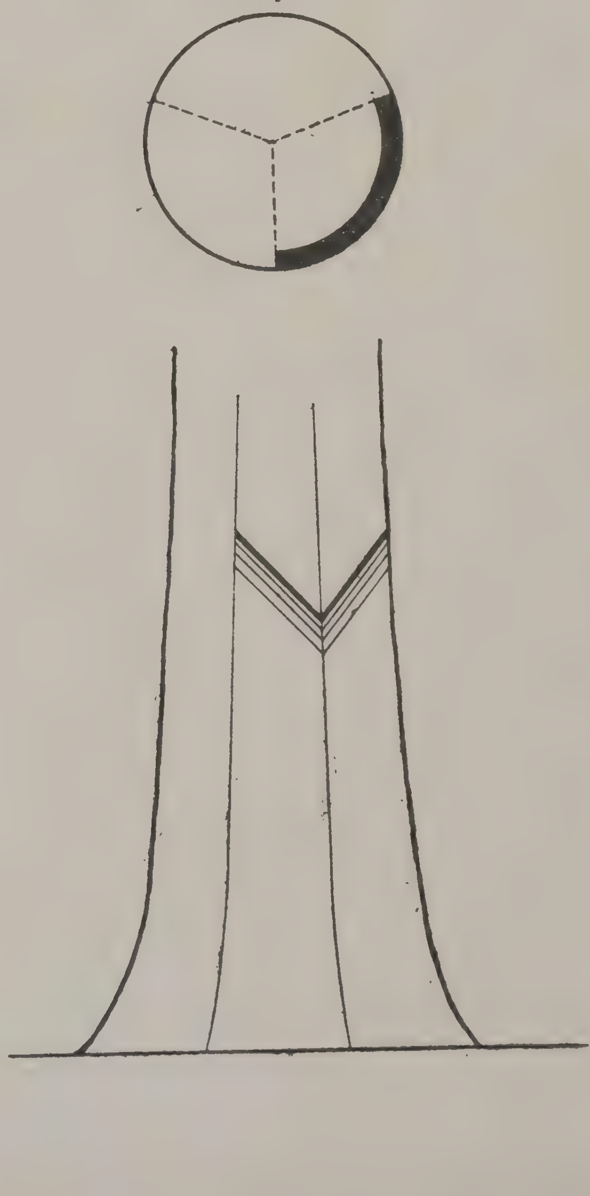

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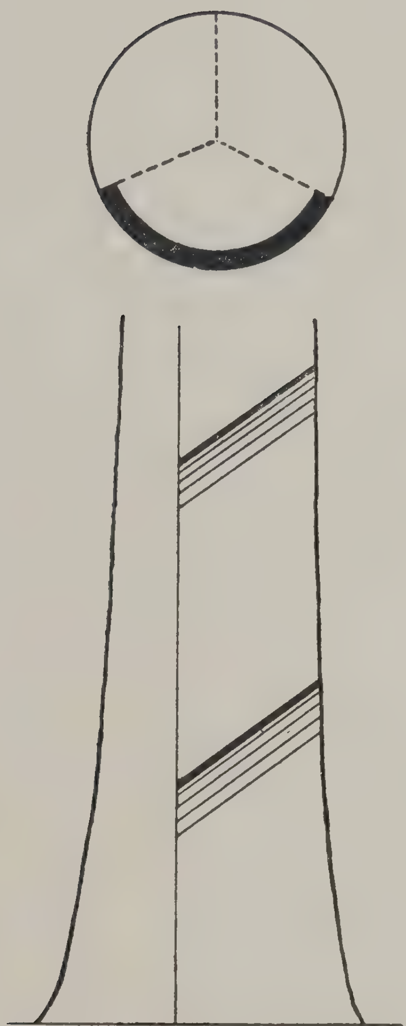

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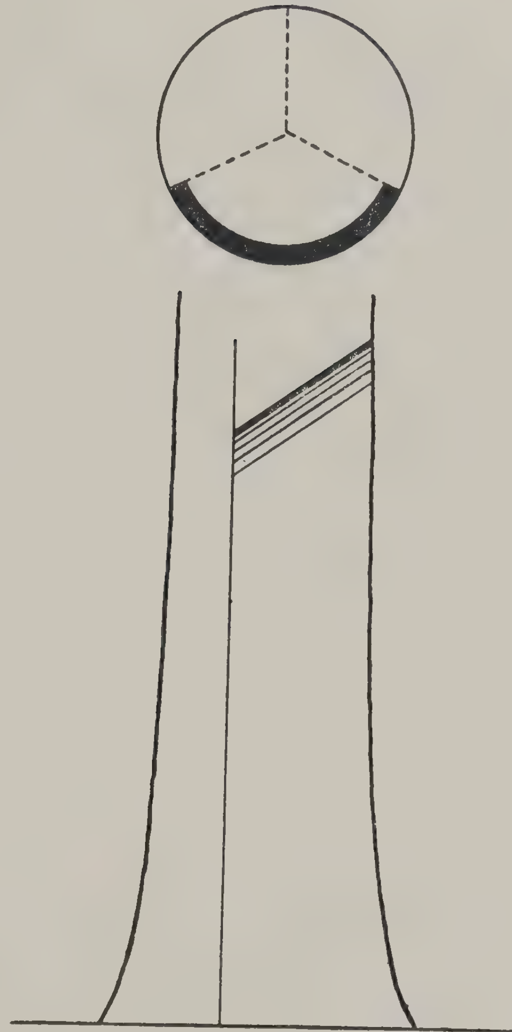

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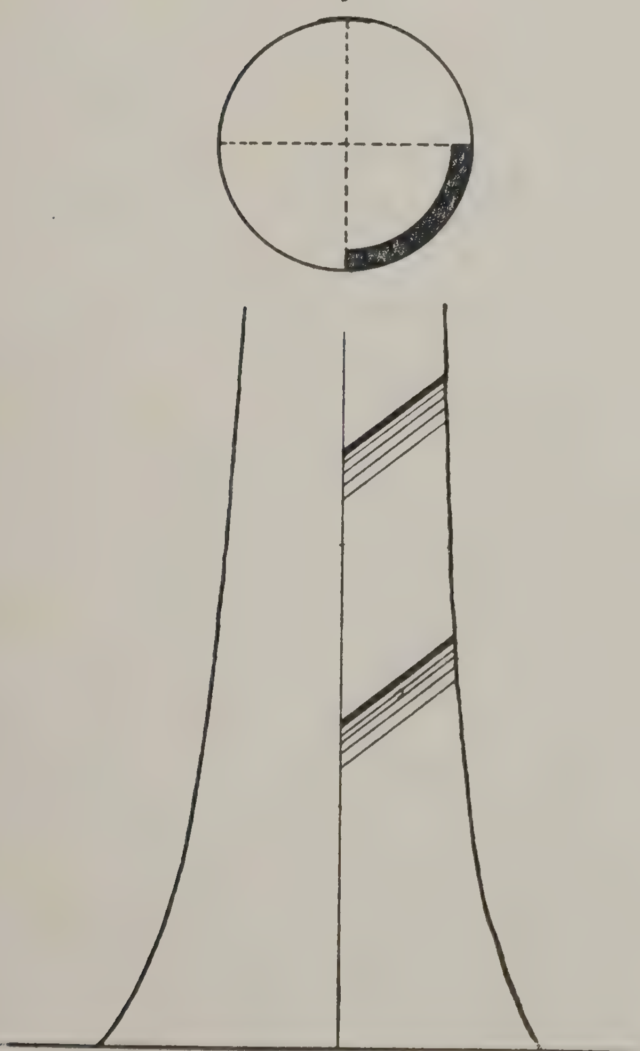

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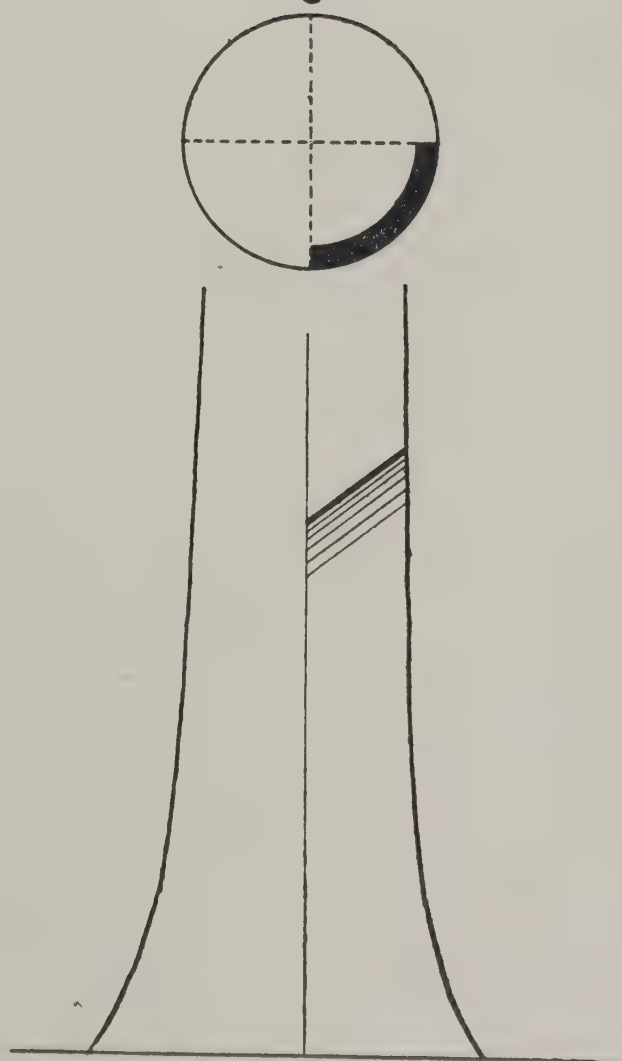

mined the yield of rubber from each of the separate cuts. If you put six cuts on the tree it seems that out of your six cuts on some occasions two at least are not of much use. One experimenter told me that when he was trying a new tapping system he tried three sets of incisions, but the three cuts were not better than the two. He got no better results from three than from two, and the yield from two was not double that from one, so that in a case of this kind it should be determined what is the difference in yield between putting two cuts on the stem and putting one. There is another thing I should like to point out, that in every case in these experiments you have two variables ; in no case is there a single variable. Take Nos. 1 and 2, you have quarter tappings, two quarters in both cases, so that that system is the same. Then you have two cuts as against one cut, and that is a variation in the number of cuts, and you have alternate day tappings as against daily tappings. That is a variation in the tappings. So you have two variables between each side of the tree instead of one variable, and if you look through the tapping experiments which have been done up to the present you will find that instead of having one variable between two sides of the tree there are five, but in this case there are only two. I do not think we can make any deductions from experiments unless you have only one factor between the different groups of trees. In this case it is clear why the two cuts were put on, and it is probably more justifiable than in many of the other experiments which have been published. Then there is another factor I should like to point out and that is the calculation of the yield per square centimetre of bark. That can only be permissible when you are absolutely certain that your coolie is cutting off exactly the same strip of bark each day. If you put on a coolie who makes 20 cuts to the inch and works through a piece of bark in 20 days, and then have another coolie who puts 10 cuts to the inch and works through a piece of bark in 10 days, the two yields are not the same. You excise the same area of bark but do not get the same yield. The yield depends —that is, considering this point alone—on the number of cuts you can put to the inch. It is the number of tappings which must govern your comparative experiments and not the relative areas of bark excised. You can work to a standard number of tappings ; that is, you can compare your yields per standard number of tappings but you cannot compare your yields per unit of bark excised unless your trees are exactly the same girth, and unless you are quite certain each coolie cuts off exactly the same width of bark every day.

Dr. Stevens : I have listened with much interest to the paper because it is on a subject which is of prime importance for plantation work, and it is one in which not a single series of experiments but many series are required, working in different parts. Dr. Petch has pointed out that there are actually two variables in each of these experiments, but of course the redeeming feature is that the bark cut away is the same amount on each side ; that is, you are cutting away the same amount of bark in the two series. However that may be, leaving that alone for the moment, we have some cases in which there is only one variable. I refer to a comparison of the results obtained on the methods 1, 3, 5 and 7, and 2, 4, 6 and 8. The only variable in comparing 1, 3, 5 and 7, or 2, 4, 6 and 8, is the method, the form of tapping, and it is interesting to compare the yields obtained in tapping these different ways. Now, for instance, in 3 and 5 in both cases the tapping area covers one-third of the tree, and in 3 we have two cuts, whereas in five we have

a single cut. In comparing the yield we find that where we are tapping two cuts alternate days, or one cut every day, we get a better yield of rubber from where we are making two cuts than where we are making a single cut. I think that is the most interesting deduction to draw from these figures. Of course, where we are tapping half the area compare 1 and 7 and 2 and 8: we get in No. 1 3,300 approximately, and in No. 7 2,600. The cuts are twice the length in No. 7 than in No. 1, but we do not get anything like double the amount of rubber. It would be interesting if the lecturer would take these figures and compare them. By placing the higher figure at 100 they would be more easily comparable, and we should be able to judge how the yields vary with the method of tapping. There is one other point I was going to ask: What was the previous tapping history of the trees, if any; whether they had been previously tapped, or were they being tapped for the first time?

Dr. Tromp de Haas: For the first time.

Mr. Jowett: There is a question I should like to ask the reader of the paper. He said we all understood tapping, but that is a point I do not understand. I happen to be a manufacturer of tools used on plantations and what I would like to ask is what tool these trees are tapped with in Java. We want some practical information as to what planters desire. I understood him to say the coolies put 12 cuts to the inch of bark.

Dr. Tromp de Haas: Twenty is the average.

Mr. Jowett: I should like to ask if he considers it would be any advantage to have a tool which would produce 40 to the inch in the hands of a first-class tapper, and 30 with a medium tapper.

Dr. Tromp de Haas: Of course if your strip of bark removed each time is too thin, if you are going to work down to a 40th of an inch, provided the bark will stand it—the bark is not like a piece of wood, and you cannot take off a piece of indefinite thinness—you would find that a part would die back in two days and you would have to cut off much more—nearer a 25th—or you would not get back to the tissue again. In the Straits they make 25 cuts to the inch, but I doubt if in Ceylon it is over 20.

Mr. Richardson: I should like to ask for some information whether in working in a country where climatic conditions make it necessary to rest the trees three months in the year it would be detrimental to go in for everyday tapping.

Dr. Tromp de Haas: I should say not. I should tap every day because you have three months' rest. At present the objection is that people are tapping every day and have no rest at all.

Mr. Clayton Beadle: I should like to ask what is the effect of the removal of the bark on the flow of latex. Presumably the object of taking off as thin a portion as possible is to save the bark as far as possible, but if you get a very thin shaving to what extent can you reduce the shaving and still maintain the maximum flow of latex. Is 20 cuts as effective as 12?

Dr. Tromp de Haas: As far as experiments have gone it is twice as effective. As far as it is known at present, the only object of taking off the strip of bark is to reopen the end of your latex tube. As long as you do that, that is all that is wanted.

Dr. HUBER: I think the thickness of parings is a very important question. I made some experiments in the Botanical Gardens at Para, and I found that 40 to the inch would be more or less half a millimetre, but in this case it is only the anterior laticiferous tubes that are opened. These tubes are generally closed to a larger extent than the interior ones. If you have an instrument to open out the interior tubes and in the next stage all the tubes, then we can take away half a millimetre in one day and free the anterior tube only, cutting in an oblique way, then cutting in an even way, we can take away one millimetre from the outer part of the bark and half a millimetre from the inner part of the bark. Of course, it is necessary to have proper tools, but I think that perhaps with skilled labour, even with a single tool, it will be possible to make arrangements to cut one day more in the interior and then only taking away a very thin shaving, another day cutting an even surface and obtaining the benefit of all the tubes. I think that perhaps the closing up of the tubes by the coagulation of latex in the tubes will continue during the day, but only in an insignificant manner, so that I think we could always obtain a good result by this method. I make this suggestion because I think with every tree it is important to take away the least possible of the bark.

The CHAIRMAN: I am afraid we must close the discussion, and I will ask Dr. Tromp de Haas if he has anything to say.

Dr. TROMP DE HAAS: I quite agree with Dr. Petch that it is not in proportion to the quantity. I mentioned in my paper that in the beginning the coolies were not trained and that they took an average of 20 cuts to the inch.

African Rubber Vines: Their Cultivation and Working.

By E. de WILDEMAN,

Lecturer at the University of Ghent, Professor of Colonial Science at the Horticultural School of Vilvorde, Belgium.

From the researches of German, English, Austrian, Belgian and Portuguese botanical explorers we know that numerous rubber bearing vines or creepers exist in tropical Africa, which vines have for some years supplied almost all the rubber for the African trade. Their distribution over the African Continent is very wide. Broadly speaking, the rubber vine area extends from Senegambia and the Upper Nile, to the south of Angola, of Rhodesia and Mozambique, even to the Cape district.

It is out of the question to review all the vines and the varying quantities and qualities of rubber they produce in Western, Eastern and Central Africa, but it may be stated that they belong mainly to two closely related families: the Apocynaceae and Asclepiadaceae[1] To the former belong the most productive species which supply, even now, the greater part of the rubber exported from Africa. These vines are therefore of special interest to the African colonies.

At present we shall only deal with true vines and not with plants whose external parts are more or less grass-like, and which yield rubber from their roots or subterraneous stems (rhizomes); thus limited, the most important rubber vines can be said to belong to two genera—*Landolphia* and *Clitandra*. A third genus, *Carpodinus*, may perhaps play a pretty important part in rubber production through one of its species, but this genus comprises a large number of varieties whose more or less abundant latex is of a poor quality as a rubber producer.

Among *Landolphiæ* those most worthy of mention, on account of their rubber yield, are: *L. Hendelotii* A.D.C., *L. Klainéi* Pierre, *L. Owariensis*, Pal. Beauvet and its next of kin, *L. Droogmansiania* De Wild, and *L. Gentilii* De Wild.

Among *Clitandræ* we find *C. Elastica* A. Chevalier, *C. Orientalis* K. Schum and the undoubtedly closely related variety *C. Arnoldiana* De Wild.

Landolphia Dawei Stapf does not belong with the *Landolphiæ*, as we already remarked in 1907, in Part V. of "Mission Laurent" (page 478), and should be placed among the *Carpodini*. We only knew this variety from the sketch published by M. Dawe and the one given in the notice of our *confrère*, Dr. Aug. Chevalier[2], but had suggested that this *Landolphia* might in reality belong to the *Clitandræ*.

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(1) Rubber vines occur in other families as well, the *Hippocratiaceae*, for example.

(2) A. Chevalier. Histoire d'une liane à caoutchouc de l'Afrique tropicale (*Landolphia Dawei* Stapffin). Bull. Soc. Bot. de France, 1906, p. 173 et suiv.

Professor E. Gilg has since demonstrated, thanks to the abundant materials gathered in the Berlin herbarium, that *Landolphia Dawei* and *Carpodinus Landolphoides* are very similar. Besides this *Carpodinus* had originally been considered by Dr. H. Hallier as a *Clitandra*.

M. Aug. Chevalier considers that this plant merits special attention at the hands of planters on account of its rapid growth and excellent product and regards it as undoubtedly the most interesting of known vines. He therefore strongly recommends the cultivation of this variety, as it is capable of yielding, at the age of ten years, 500 grammes (1 1-10th lbs.) of dry rubber yearly, even on cacao plantations and trained on shade trees. According to him the cultivation of this vine or of similar ones would serve to lessen the risks of single variety cultivation. But we are not now inquiring to what vine preference ought to be given. Our purpose is to insist on the general usefulness of rubber bearing vines.

Notwithstanding many favourable opinions, the various species of vines, although undoubtedly producers, have neither been cultivated nor worked as they should be. Nearly all the African rubber brought over to Europe, especially from the Congo, has come from wild growing plants, and very often the native, through an intensive and altogether irrational harvesting, has caused a reduction in the number of producing plants, if not their disappearance. This latter side of the question has given rise to the conclusion often voiced by the Colonial agriculturists, and endorsed by the Governments of the African colonies, that the cultivation and working of the African rubber vines is not a paying proposition.

In 1909 the Belgian Colonial Department, following up the Government of the Congo Free State, which had always bestowed great care on the rubber riches of Central Africa, inserted in its instructions to agents[1] the following :—" Although vines supply rubber of a better quality than that of the trees, including *Funtumia Elastica*, and although it is very probable that the trade will always look to them for good quality rubber, either red or black, for special purposes, preference is to be given to the cultivation of rubber trees. The less vigorous and more irregular growth of the vines tends to delay in working them, and their thin stems cannot yield as important a harvest of rubber as that given by trees. Besides, the vines, owing to their tortuous growth, do not afford the same facilities for rational extraction of latex as do the trees with their thick, straight trunks. Finally, they must have trees to grow on, and thus part of the plantation is occupied by non-productive trees, which causes a diminution in the ratio between tapping surface and plantation area."

If these remarks be accepted as true, we should certainly have to advise that the cultivation and even the working of vines be stopped and that imported plants, especially *Hevea*, be energetically cultivated under rational conditions. But has not this conclusion been arrived at a little too hurriedly, without all the elements of the very complex question having been studied and weighed as they should have been ?

Let us see what care has been given in Central Africa to the working and cultivation of the rubber vines.

The Government of the Congo Free State, one of the first, has, since 1899, required through a Royal decree dated 5th January, that a

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(1) Manuel pratique de la culture et l'exploitation des essences caoutchoucifères indigènes et introduites au Congo Belge. Bruxelles, 1909, p. 53.

certain number of vines (150) or trees be replanted for every ton of rubber exported. In its ordinance of 18th June, 1902, the Government raised the required number from 150 to 500 plants. The text of this modification reads as follows :—" The Commissioner of the district makes known to interested parties, concession holders and agents either of the State or of companies, as well as private individuals, the number of rubber plants to be planted each year and the place for each plantation, which place is to be situated when possible in close proximity to the settlements or harvesting posts. However, the fact of not receiving said notification does not exempt the parties above mentioned from establishing every year in the forests of the estate plantations of at least 500 plants to each ton of rubber harvested, according to Ordinance II. afore-mentioned."

This ordinance has been prompted by the laudable desire to protect the natural resources of the colony. It was most rational in itself, and the example set by the Congo Free State has been followed by others. But, as is seen by the text given above, the ordinances did not specify which variety was to be cultivated, the choice being left entirely to the companies and the colonists.

How was it possible to establish plantations at the time when the rubber bearing varieties were very little known in Africa and when very often the agents of the State or of companies were neither familiar with agricultural botany nor with the most elementary principles of cultivation? Moreover, the orders coming from those in authority very often showed signs of a lack of the necessary knowledge characteristic of new enterprises.

The regulations transmitted to agents advised the plantation of vines only in places where the soil was too moist for the cultivation of trees[1], but it was also permitted to plant them on slopes and on the sides of mountains with sharp declivities, in order to retain the humus—as if these vines could be made to grow anywhere! While admitting that certain soils are better adapted to vines, it was insisted that they should only be cultivated in places unsuitable for other varieties such as cacao trees and rubber trees! A secondary place then was given to these vines, which had hardly been the case before 1909.

At first cultivation consisted of seeding in nurseries and setting out the plants afterwards in the woods; or else direct seeding in the woods or in the forest roads. It was soon found that while vines can be grown from the seed, they attain, in the forest, insignificant dimensions. To obtain plants as vigorous as the vines worked in the forest by the native, under the conditions there existing, one would have had to wait a considerable number of years.

The result of this very correct observation was naturally unfavourable to the progress in the cultivation of vines, their great fault in the eyes of the Government being the slowness of their growth.

But one of the conditions of the experiment had not been thought of—the biology of the plant had been altogether overlooked.

To allow a plant to develop normally one must give it not only the necessary soluble mineral elements through the soil—it must also absorb through its leaves the carbon from the carbonic anhydride contained in the air. What does a plant require to effect this decomposition? Light and chlorophyll.

By planting vines under the shade of trees you put them in very unfavourable conditions for accomplishing this assimilation because

(1) Loc. cit., p. 54.

they are deprived of sunlight. The vines now being exploited in the tropical forests have developed very well, because they grew up with the forest, exposing their leaves, flowers and fruits to the sun together with the trees. This error having become apparent, the recent orders to agents, based on more scientific principles, read as follows :—"Generally, the most favourable places for vine plantations are in young forests rather thin and with few large trees. Experience has shown, indeed, that vines will grow very well in completely broken up soil. Vines can also be cultivated in the open by planting a prop tree for every four vines. To this end the sham cotton tree, *Eriodendron anfractuosum,* can be used to advantage.[1] The place for planting is not in the forest, not even in the more or less wide paths cut through them, but in the cleared forest, in the bush, so that the vines may grow up with the second growth trees. It is not then necessary to arrange props for the vines.

But other conditions also, especially the manner of obtaining the latex, have also caused certain Governments and agriculturists to regard vines with disfavour.

The regulations have required tapping everywhere, and until very recently this was the only method allowed to be used on the Congo, either for trees or vines, exception being made only in case of the rubber bearing grasses. But tapping could not be operated with any chance of success on cultivated vines whose stem after four or five years only measure from 2 to 3 centimeters ($\frac{3}{4}$ in. to $1\frac{1}{4}$ in.) in diameter! This small diameter is, as we have said before, mainly due to the conditions under which the vines have developed. Tapping is, then, useless in case of young seedling vines. We have often set forth these objections against the tapping process, and lately several of our *confrères* have taken the same stand.[2]

Everybody now agrees that the methods of gathering rubber or latex used by the natives of Africa are more or less defective. One seldom sees a case where the native extracts all the rubber contained in a vine. Let us pass in review different methods of extracting latex ; they are not numerous, and are very much the same in all parts of Africa. They may be divided into three classes.

The first method consists in pulling the vines off their props to get at them easily. The native then very often spreads the stems more or less parallel to the ground, keeping them a certain distance from the soil by means of supports. Afterwards he makes incisions in the stems at regular distances and gathers up the latex which flows out. Then comes the process of coagulating, upon which we shall not dwell here. This procedure has been considered rational by many colonists, on the ground that the native was using foresight in letting the vine live and in cutting it only in places. But have those who upheld this method considered what becomes of a vine treated in that way ? Where is the plant that after being pulled off its props, even though carefully, and deprived of access to sunlight, will ever go on with its normal vegetation ?

We can assert without hesitation that the greater number, if not all, the plants thus treated must and will die in the underbush, not only

(1) Manual pratique, op. cit., p. 80.

(2) E. De Wildman. "Encore à propos de l'exploitation des lianes à caoutchouc en Afrique." Le Caoutchouc et La Gutta Percha ; Paris, le 15 Décembre, 1908, p. 2491. See also E. De Wildman. "L'exploitation des lianes à caoutchouc en Afrique tropicale" ; L'Agronomie Tropicale, Bruxelles, le 25 Février, 1909, p. 17.

because of the unfavourable conditions for vegetation, but also because the wounds caused in the pulling down and tapping will become infected with plant diseases, against which not the slightest precaution has been taken. The reply may be made that the plant will throw out new shoots. That is possible, but they will be few in number because the vine will first try to heal its wounds and to fight the microbes that invade them, and will nearly always exhaust itself in futile efforts.

One of the reasons against cutting the vines—and a very poor one at that—was " that every attempt in this direction would tend to keep up this nefarious practice and would make the enforcing of the law prohibiting the cutting of the vines and the threshing of the barks even more difficult than under present circumstances."[1] A very poor argument in my opinion. There should not be any question of law here ; the law should be made to facilitate the improvement of the land, and if it fails in this respect, either partly or wholly, the law should be altered. At all events, this native method (*i.e.*, cutting or tapping) which we have explained and which appears so rational at first sight, ought to be given up—in fact, prohibited.

Another method used by the natives, a method recommended and regulated by different administrations, consists in tapping the vines without pulling them down.

The method of tapping advised by the Belgian Colonial Department, amongst others, is merely a copy of the one which has given magnificent results in the case of *Hevea*. They have attempted gradually to modify the native method of tapping, and have adopted the partial removal of the bark, an idea brought to the fore by the planters of the Federated Malay States, Ceylon, and the Dutch Indies.

But if this method, supposed to be a good one for *Hevea*, has already found opponents by whose authority certain changes have been made in the original system, and if it has been found necessary to tap trees with special care under certain special circumstances, will it not be necessary in case of vines as well ?[2]

In 1909 the Agricultural Section of the Belgian Colonial Department specified the following points to be observed in tapping :

1. The incisions to be made with a sharp knife after cleaning the surface to be cut.

2. The distance left between the incisions to be from 20 to 25 centimeters, and the tappings to be made one directly under the other, so as to affect one side of the stem only during a harvesting.

3. The strips of bark taken off to be not more than 6 centimeters long.

4. It is best to re-open the wound as long as the vine gives latex ; but this can only be done once a day, or better, every other day.

Another objection to tapping is that it is impossible to make the natives (who have little inclination for regular work) perform so delicate an operation as the one required here. Besides, it is very difficult, in

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(1) R. Kindt. Bull. de l'Association des Planteurs de caoutchouc ; Anvers, 1909, p. 23.

(2) H. A. Wickham. " On the Plantation, Cultivation and Curing of Para India rubber," London, 1908, p. 37, et. seq. De Wildman. " A propos de la saignée des plantes caoutchouciferes," Agronomie Tropicale, 1909, p. 33 ; also De Wildman Bull, de l'Assoc. des Planteurs de caoutchouc d'Anvers, March, 1909.

case of vines of limited diameter, to make cuts or incisions that do not reach the wood.

In fact, we claim that every vine tapped is a vine lost.

A recent experiment by F. Seret, director of the Garden at Eala (Belgian Congo), confirms this opinion anew. A *Clitandra Arnoldiana* vine yielded in 1907, 100 gr. of rubber; in 1898 it gave 87 gr.; while in 1909 it was dead even to the roots. F. Seret adds that this vine had been tapped with every possible care, a tapper (tapping knife) being used. Therefore he naturally comes to the conclusion that, "In most of the districts of the Colony where the natives follow their way of working (tapping with or without pulling down the vines), it is beyond doubt that after the first harvest *Clitandra Arnoldiana* is doomed to certain death."[1]

M. Aug. Chevalier also has become decidedly convinced of the the utility—nay, the necessity—of cutting the vine, though he does not seem altogether in favour yet of threshing. In one of his notes on the forests of the Ivory Coast, he writes: "If cutting the vines in the forest is prohibited, their working will necessarily be prevented, there being no other way of making use of them."[2]

In a note published in the Annales de la Société Scientifique de Bruxelles,[3] in the Bulletin de la Société Géographie de l'Est, and among the data contained in "La Mission Laurent"[4] we proved that much more was got from the vine by threshing than by tapping, since nothing is lost.

Cutting constitutes the third method, which is, after all, a modification of the first one, and is often followed up by threshing. The native pulls the vine off its prop, then instead of tapping it, cuts it in pieces and gathers the latex which flows from the ends. This method at first sight looks destructive, but when carefully examined proves to be superior to all others. Indeed, we may say that this is the method of the future, but some modifications have to be made to certain details of its application. What now, are the objections that can be raised against this method? Only one of importance: The latex does not all flow out of the pieces of the vine, therefore a considerable quantity of the rubber is lost. It has also been objected that the native kills the vine by this barbarous process. This is an error; a vine is not killed because it is cut.

This cutting does not destroy the rubber resources of the district. On the contrary, the natives of many a Congolese district have very openly declared to certain white agents that from the day cutting was no longer permitted rubber harvesting would go to ruin on account of the destruction of the vines through tapping. The natives know very well that a vine when cut is not lost, but that its recovery is certain, at least, when the cutting has been done in such a way as to leave *sprouts* which are capable of development. Therefore in cutting the vines they are looking to the preservation of the rubber resources of the country.

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(1) Bulletin Agricole du Congo Belge, November, 1910, p. 50.

(2) See E. De Wildman. "Notices sur plantes utiles et intéressantes," Fl. Congo, Vol. II., p. 200, et. seq.

(3) E. De Wildman. "La Géographie du caoutchouc et son exploitation." Bull. de la Société de Géographie de l'Est, 1907, p. 428.

(4) E. De Wildmann. Mission Laurent, Bruxelles, 1905–1907, pp. 468–520.

There remains enough life in the stump to allow the sleeping buds to come into vegetation, and these will become shoots large enough to be worked sooner than shoots obtained by seeding.

If it is left to the native to cut down every rubber plant he meets without using any discretion, one would see the number of rubber producing plants go down to a certain extent, and that has occurred ; but if care is taken in choosing the plants to be cut down, or even if the native is left to do it by himself without being driven to supply excessive quantities, the stumps will grow again, and will be able to produce rubber after a comparatively small number of years. The native has no interest in destroying the rubber reserves, which are a source of great revenue to him.

Often the ends of the vines, after the latex has flowed out of them, are left on the ground in the forest, and one of our old and lamented pupils, A. Courboin, has observed in the forests of French Congo such ends develop like regular slips. Unfortunately, this case is rather rare, and does not lessen the force of the greatest objection that can be urged against the method of cutting only—namely, the loss of useful material. To turn this so-called barbarous process into a rational method it is only necessary to separate the remaining rubber mechanically. This last process is, as we have often asserted, bound to become the method of the future, especially for Africa.

But even it be admitted that the working of vines is made possible by cutting and threshing, there is still a great difference of opinion as to whether the cultivation of vines can be made to pay. A great many African agriculturists and explorers consider that there is no future in the cultivation of vines, that it is the best thing to work those that are in existence and to favour their reproduction by giving the young seedlings, of which there are so many in the forest, a chance to grow by giving them more light.

But is this all that can be done ? If one has to wait until the seedlings whose development will be hastened by giving them light, are large enough to cut, it may take ages.

We think not. We think that the *cultivation* of vines has certain advantages in tropical Africa. First of all, the plants are on their native soil and their development is certain under conditions where most of the other varieties could not grow ; then again, their cultivation requires little care, and the native can easily look after them. In fact, the cultivation of vines could be managed entirely by the native, and the white man, either agent or planter, would only be needed in harvest time. The moment a vine plantation was considered to be in condition for harvesting the white man would come on the scene with his extraction apparatus to gather in the rubber. Even though the yield be small, it will be large enough to cover the costs of the working and give a profit, the labour required in obtaining the rubber being reduced to a minimum. We have pointed out in " La Mission Laurent " [1] that estimating the yield of a six-year-old vine at 50 gr. ($1\frac{3}{4}$ oz.) of dry rubber—a figure lower than the various experiments conducted in Belgian Congo have given —regular plantations would be able to produce 330 kgs. of rubber per hectare (291 lbs. per acre) with seven-year-old plants whose off-shoots would be large enough to yield again in six years from the first cutting.

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(1) E. De. Wildman : " Mission Laurent," page 520 *et seq.*

Let us recall the results of experiments conducted in Belgian Congo by M. Cranshoff on a *Landolphia Owariensis* vine seven years old.

Tapping of the oldest stems and the main branches	18 gr. (⅔ oz.)
Crushing of the barks and stems after tapping ..	37 gr. (1⅓ oz.)
Crushing of the branches left untapped	8 gr. (¼ oz.)

On a total of 63 gr. 45 gr. have therefore been obtained by the very crude mechanical process, and were made up of rubber which would have been irretrievably lost by the other methods of extraction.

M. Seret has conducted experiments on the same lines in the Garden of Ealor, and has given the following figures for *Landolphia Owariensis*[1] :

Rubber from the latex.	Rubber obtained by crushing.
8 gr. (¼ oz.)	6 gr. (1-5th oz.)
57 gr. (2 oz.)	180 gr. (6⅓ oz.)
150 gr. (5 3-10ths oz.)	720 gr. (1 6-10ths lbs.)
2 gr. (1 dram)	23 gr. (8-10ths oz.)
26 gr. (9-10ths oz.)	135 gr. (4½ oz.)
70 gr. (2½ oz.)	250 gr. (8 8-10ths oz.)
4 gr. (2 drams)	27 gr. (9-10ths oz.)

The quantity of rubber obtained by threshing is therefore in certain cases ten times that obtained by tapping.

Are not these figures decisive and do they not strongly uphold our opinion with regard to the working by cutting and threshing ?

M. Teissonnier, Director of the Experimental Garden at Conakry, discussed the question as to the yield of the vines in 1907 during the Congress at Bordeaux.[2]

" If," says he, " the yield in rubber of the aërial part of the vines from two to four years old had been large enough, the cultivation of *L. Hendilotii* would have been assured. . . . Unfortunately, at this age the aërial part was unable to cover the costs of the working, and the process was not followed any further."

How can so drastic a conclusion be arrived at after such experiments ? On the one hand, M. Teissonnier admits that it is out of the question to tap vines before they are 10 years old ; on the other, he wants to obtain rubber by crushing the bark of vines when they are only from two to four years of age. This seems rather unreasonable to us. While upholding the great advantages to be derived from working the vines through the crushing of the bark, we have always maintained that this referred to the bark of full-grown plants. The plants should be cut and their stems stripped of the bark, the off-shoots of the stumps could in turn be worked by cutting and threshing, and much earlier than if they were seedlings.

One cannot compare the chemical constitution of tissues in young plants with those in off-shoots of full-grown plants ; the latter are aided in their development by a well-established system of roots.

In most of the experiments conducted in order to determine the value of mechanical extraction of rubber from cultivated plants no thought has been given to the difference existing between the stems of seedlings and those of offshoots of the same age. It cannot be denied, in view of the experimental results, that shoots from an old stump which has been cut down give rubber as soon as they are from three to four years old.

(1) We cannot recall the conditions of the experiment. See Bulletin Agricole du Congo Belge, November, 1910, page 50.

(2) M. Teissonnier. " La liane gôine en Actes," Colonial Congress at Bordeaux, 1907, p. 67.

The Bordeaux Congress itself admitted the value of the mechanical processes, and anxious to see this question cleared up, it expressed its wish "To conduct, in the Congo, trials of methodical extraction by threshing." Let us hope that this wish will be taken into consideration, not only in French Congo, but in the other West African colonies, even in those where, after unfavourable experiments, this method has been rejected altogether. We still persist in considering it of very great value.

The machines (for mechanical extraction Tr.) which have been sent on have all certain faults and have all to be altered before they can become of practical use.

The bark must be crushed on the spot. It is out of the question to handle it in Europe; the costs of transportation would make this a poorly paying business.

The mechanical process is capable of producing pure rubber, as nothing has to be added to the gum, while the methods for coagulating the latex bring about more or less important changes in the chemical nature of the product.

The opponents of the cutting and threshing system have claimed that certain vines can not be treated by this method, the latex being either too watery or the rubber produced being too small in quantity, and from observations made in Africa they seek to prove the general unavailability of the process.

This opinion seems to be supported by the results of certain experiments recently conducted at Eala by F. Seret. In fact, with regard to the *Clitandra Arnoldiana*, Seret gives the following results:

Rubber obtained by coagulation of latex.	Rubber obtained by threshing.
52 gr. (1 8-10ths oz.)	0
45 gr. (1 6-10ths oz.)	2 (—1 dram.)
35 gr. (1¼ oz.)	0
61 gr. (2 1-5th oz.)	0
22 gr. (¾ oz.)	0
3 gr. (1 dram.)	0
29 gr. (1 oz.)	0
350 gr. (12⅓ oz.)	0
60 (2 1-10th oz.)	0

On the other hand, he informs us that at Bena-Dibele, for the same variety, 214 gr. (7½ oz.) of rubber had been obtained by coagulating the latex and 17 gr. (6-10ths oz.) by threshing. So evidently there are differences there in the results which call for verification.

However, from these partly negative experiments Seret concluded that it would be proper in the case of the *Clitandra* to extract first the latex, by tapping, which ought to be carefully done, of course; then after a while, the proper time having yet to be decided, to harvest the balance by cutting up the roots as well as the main and secondary stems or branches.[1] But from the observations made by Messrs. Sapin, Farrene, and other Africans, it appears that all the rubber bearers of Africa, whether trees, vines or grassy varieties, will yield rubber under the mechanical process. In order to get results, slight modifications require to be made in certain special cases, where the native method of

(1) Bulletin Agricole du Congo Belge, Vol. I., 1910, p. 51.

threshing is too violent.[1] Godefroy Le Beuf was, we think, the first to advocate strongly the mechanical process, which we have always held to be the only one capable of making the vines pay.

Contrary to this recently expressed opinion of M. Brenier,[2] we are not alone in our advocacy of either cutting and beating or cutting and drainage. Messrs. Aug. Chevalier and Y. Henry are also in favour of the cutting, and Mr. J. Booth,[3] an Englishman, considers that so long as the roots of the vines are not destroyed to extract their rubber, (a thing which is becoming more difficult in the districts where the preservation of the natural resources is looked after properly), the productive plants can be preserved for a long time provided they are not tapped too early and the tapping is done carefully. On the other hand, if the tapping is done carelessly and before the right time, the future of the industry is bound to suffer.

According to this author, the only way to protect the vines against the irrational working of the native is to reserve the districts which are rich in rubber-bearing plants, and when those districts are invaded to drive the natives out of them to regions where the natural conditions of growth for the vines do not exist.[4]

Most of the opinions here expressed have also been dealt with recently in M. de Mello Geraldes' excellent book.[5]

He does not hesitate to draw the conclusion that the method which to-day seems to be the one natives should use is the mixed method, namely: to extract the largest possible quantity of latex from the vines without tapping them any higher than 1.50 m., afterwards to cut them 1.50 m. (5 ft. 2 in.) above the ground and extract the rubber from the bark of the pieces that are cut. And he even adds: "In conclusion, it would be against common sense to prohibit cutting and extracting rubber from the bark of the vines, as one knows that most of the rubber produced in Angola comes from the barks of the rhizomes of *Landolphia*, *Thollonii* and *Chylorrhiza*. Any distinction here is impossible."

We have been pleased to see the Belgian Colonial Department admit, by its ordinance published in March, 1910,[6] the cutting of the vines under certain restrictions.

This ordinance gives satisfaction to a certain extent to all those

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(1) See on this point the observations of Sapin in E. De Wildman's "Mission permanente d'études de la Cie du Kasai," Bruxelles, 1910.

(2) H. Brenier: "Le caoutchouc de plantation en 1909 et son avenir," in Bulletin économique de l'Indo-Chine, No. 83, March and April, 1910, p. 227. et seq.

(3) J. Booth: "Einiges über Landolphia," in Tropenpflanzen, Dec., 1905.

(4) Cf. E. De Wildman: "Mission permanente d'Eludes scientifiques Cie. du Kasai," p. 39.

(5) C. E. De Mello Geraldes et B. d' Oliveira Fragateiro "Le Caoutchouc dans les colonies Portugaises." Lisbon, 1900, p. 46.

(6) Bulletin Officiel du Congo Belge, No. 7, March 25, 1910. See also E. De Wildman, Compagnie du Kasai Mission Permanente d'Etudes Scientifiques. Resultats de ses Récherches Botaniques et Agronomiques mis en outre et annotés, par E. De Wildman." Bruxelles, 1910, p. 36.

who like ourselves have been advocating for years the necessity of cutting the vines; this is a first success, and we hail it with pleasure.[1]

Unfortunately, it does not allow threshing, and therefore this new regulation would cause a considerable proportion of rubber to be lost were it not that in a great many cases the native can do as he pleases when away from the supervision of the white man, and often acts in direct opposition to the rules drawn up in the metropolis.

Since the publications of Godefroy Le Beuf, the idea of applying mechanical processes to extract rubber has gained ground. They have been advocated not only for the vines but also for such trees as the *Funtumia Elastica*. M. Farrene, of the Agricultural Service of the French colonies in West Africa, backed by our learned friend, Dr. Aug. Chevalier, has re-considered this process, and draws the following conclusion: "*Funtumia* has therefore to be treated by regularly cutting, threshing and crushing the bark, not only to obtain a maximum yield but also to make sure of preserving and even increasing the value of the plantation, since the natural regeneration and replenishment of the *Funtumia* guarantee the perpetuity of our operations." [2]

Putting everything together, then, we must come to the conclusion that cultivation of the vines should not be given up in Africa. On the contrary, under the present conditions of cultivation and labour, encouragement should be given to the multiplication and the working of the vines.

This cultivation must be left to the native; it would never be a paying business for the white man. And if results are to be obtained, the vines must not be consigned to altogether unproductive fields only. Vines are just as sensitive to their surrounding conditions as are other plants.

If the native is to be the cultivator and, in many cases, the harvester of the vines whose development he will have brought about or facilitated, the governments and companies will find it to their interest to favour the multiplication of the vines and the regulation of the production in order to keep it going regularly. Therefore a regulation for rubber growers and workers ought to exist in the African colonies. The one, M. Yves Henry, submits is very sensible in most of its provisions and in accordance with the arguments brought forward by most of those who have busied themselves with the study of rubber-bearing trees in tropical Africa.

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(1) Paragraph 10 of this ordinance says: The latex of rubber trees must only be gathered by incisions made in the bark of the trunk without penetrating the cambium. Vine rubber must only be gathered by incising, tapping or cutting the plant. It is forbidden to tear out, tap, gash, or cut up the roots of the plant, or to tap, gash or cut up the main stem any lower than 1.50 m. (5 ft. 2 in.) above the ground.

This article, which does not refer to the "grass rubber" varieties, replaces Article 4 of the Royal Ordinance, dated 22nd September, 1905, which specified: "The rubber from either trees or vines must only be extracted by tapping. It is forbidden to cut down rubber trees or vines, or to peel off the bark and extract the rubber of the trees or vines by threshing or crushing the barks of vines or by any other way than prescribed in the first line of the present article."

Article 10 of the new ordinance, though still somewhat vague, not referring to the "grass rubber" varieties, and the like, gives the collector a certain freedom, which makes for the preservation of rubber plants.

(2) See on this point C. Farrene. "Sur un projet de mise en valeur des territoires forestiers des cercles de l'Indecie et du Boudonkon (Ivory Coast) par la constitution de plantations methodiques du Funtumia Elastica," Paris, 1910, also "Note sur un nouvean régime d'exploitation du Funtumia Elastica," in the Journal d'Agriculture Tropicale, Paris, Nos. 109, 111 and 112.

M. Henry's proposals may be grouped around four main ideas : [1]

1. Improvement of the quality, prevention of fraud.[2]
2. Preservation of the existing stocks.
3. Starting new stocks.
4. Education of the native.

We do not propose to examine here in detail the arguments brought forward in favour of three of these principles which are certainly most valuable to the improvement of the African colonies.

Topic 3 interests us particularly, inasmuch as we also consider it necessary to re-stock with rubber vines those districts that have been stripped of their resources by too intensive and irrational a working.

Propagation of the vines can be accomplished by : (1) seeding, (2) setting out slips, and (3) by cuttings.

Vine seeding must be done in thinned out secondary forests or in the brush around the villages. They will have the great advantage of affording protection to the forests and brush against the prairie fires which are started periodically by the natives.

This way of propagating the vines does not at all require props for the plants ; if the process of cutting them is applied in the working, they can be allowed to grow as bushes.

At the time of cutting, only those stems which are capable of producing commercial rubber by tapping and threshing should be chosen.

Let us remember the remarks made by Mr. Baudon about the setting out of slips and cuttings, also those of our late pupil Albert Courloin.[3]

We may also mention experiments recently made by our pupil, M. A. Sapin, which show the importance of setting out slips. He has uprooted in abandoned nurseries a certain number of plants of *Landolphia Klainei*, and has threshed the roots to extract the rubber ; then the stems, whose grassy parts had been taken off, have been set horizontally in the ground ; they have taken root and giver *aërial* shoots some of which, after six months, reached a height of 1.50 m. (5 ft. 2 in.). As we have said, this is a sure way for rapidly propagating robust and productive plants without loss of rubber. From the roots of the plants thus pulled out, M. A. Sapin has been able to extract by threshing a quantity of rubber which he values at 100 kgs. per hectare (9-10ths lb. per acre) from *Landolphia Klainei* and 50 kgs. (– ½ lb. per acre) from *Landolphia Owariensis*.

From an agricultural standpoint we declare ourselves strongly in favour of the native varieties, not only for economical but for educational purposes, though we do not mean to oppose the introduction of valuable foreign varieties. But we consider that these should not be cultivated wholesale until they have been properly tested.

There are, moreover, economic considerations which might in certain cases encourage the cultivation of the native rubber trees or vines, especially where their natural produce is of good quality.

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(1) Yves Henry. "Le caoutchouc dans l'Afrique Occidentale Française," Paris (A. Challamel), 1906, p. 132.

(2) A recent ordinance, dated 16th January, 1911, regulates the punishments for frauds in the rubber prepared by the natives in Belgian Congo. See Bull. Off. du Congo Belge, No. 2, 10th February, 1911, p. 89.

(3) See A. Baudon. "Le marcottage des lianes à caoutchouc," in L'Agronomie Tropicale II., 1910, p. 9 ; also E. De Wildman in Mission Permanente d'Etudes de la Cie. du Kasai, 1910, p. 29.

For example, in the Malay Peninsula we have seen land planted with *Hevea* reach the price of 23,000 francs per hectare (£365 per acre) before even the trees were old enough to be tapped, while a few years before they were only worth about 500 francs (£8).

Under such economical conditions the returns of the cultivation are totally altered, and this we consider another argument again in favour of the working of native varieties which only require a very small capital to start with—and that is Brenier's point. According to him, this exaggerated increase in the price of rubber-growing fields strongly favours the rubber which grows wild in Amazonia and Africa, because there is no outlay of capital for the ground.[1] By helping the native to cultivate and work the rubber vines rationally, the production of rubber will be increased in the African colonies ; and this is of considerable value for Central Africa, as rubber stands transportation better than any other product.

By giving the native, in this way, a constant source of revenue, you will attach him to the native soil. Greater progress will therefore be made in the civilisation of the centre of Africa than if the native comes and works more or less regularly on the plantations managed by the white man; for instead of a mere wage earner you will have made of him a husbandman, fully aware of the value of his native soil.

The CHAIRMAN: This paper is of very great interest. Some of the particular points on which Dr. Wildeman has laid stress are points on which there is active difference of opinion, as I have had opportunities of seeing from different papers on the subject. The question whether the cultivation of vines will ever pay in Africa is, evidently, from the literature, a debatable question. He evidently holds a strong opinion on the point. His second question of the mechanical method, and his peculiar method of exploitation, is interesting, and I have not come across much mention of it other than as I have said, in the papers. I hope we shall have a good discussion on the paper.

Dr. PAROLE, speaking in French, said that the extraction of this latex was used in several districts in Madagascar successfully.

(1) H. Brenier. "Le Caoutchouc de plantation en 1909 et son avenir," from the Bulletin Economique de l'Indo-Chine, No. 83, p. 236.

Notes on the Cultivation of Para Rubber.

By WALTER FOX,

Late Superintendent of Forests and Gardens, Straits Settlements

MR. CHAIRMAN AND GENTLEMEN,—

Before reading the few notes I have prepared on the subject set down for discussion to-day, I should like to say that it is only a few days ago since I was asked to read a paper on this important subject. The consequence is that I have not had the time to make anything like so complete a paper as I should have wished, and it was only on the condition that what I had to say was more in the nature of an introduction of the subject for the purposes of discussion, that I undertook the task. Now, gentlemen, I suppose everyone in this room has some knowledge of the cultivation of Para rubber—many of you have very extensive and practical knowledge, others perhaps only from reading the literature on the subject; for anyone who has only read that fascinating pamphlet written by Mr. Ridley, called "The Story of the Rubber Industry," must at least have a nodding acquaintance with this marvellous and gigantic industry. My own experience of the cultivation of the *Hevea* is practically coincident with its introduction to the East 33 years ago.

In 1876, the year Mr. Wickham successfully brought the seeds to Kew, I joined that establishment, and saw the seeds germinate and the seedlings despatched out East, and after completing my training there, followed them out three years later, *i.e.*, to Singapore, in 1879. There I found about a dozen trees or so planted by the Superintendent, Mr. Murton, in what was known at that time as the Economic Garden. Unfortunately the soil in this part of the Gardens was very poor, and in 1881 some 100 odd acres, known as the Military Reserve, was added to the Gardens, and in a low-lying portion of it a fresh Economic Garden was made, and the young *Hevea* plants transferred there, where they made rapid growth. In the year 1883, I think, eleven gunny bags of *Hevea* seeds were received from Dr. Trimen, of Ceylon; these were sown in the new gardens, and it is mainly from these trees, supplemented afterwards from the seeds produced by our own trees that a very large number of the trees now in the Federated Malay States were raised. I have mentioned that the low-lying portion of the new gardens was selected, and the reason of that was that Mr. Alex. Cross, who was also employed by the Indian Government in introducing not only *Hevea*, but *Ceara* rubber and cinchona as well, was at Kew when I was there, looking after the plants and seeds he had introduced. He told me in many conversations I had with him, how that the *Hevea* was found in low-lying land subject to periodical inundations, and that this was the ground to be recommended, hence in the early days of planting, that was one of the instructions

given to planters to choose low-lying land. Of course, subsequently we found out that *Hevea* was not exclusively confined to these low-lying grounds, although I may add that in South America—from where I have only just returned—the rubber collectors regard the rubber from the inundated parts of the country as the strongest and the best. As you are aware South America is the home of the genus *Hevea*—and for many years after its introduction to the East, *Hevea Brasiliensis* was considered to be the only species. Now, however, whilst botanists are not quite agreed as to the exact number, it is admitted that there are about fifteen well-known species, and when those recently collected by myself in Peru have been worked out, I expect two more species at least will be added. Out of these fifteen or more species—*Hevea Brasiliensis*, which undoubtedly produces the best rubber—has an enormous geographical range. I have myself seen it on the Atlantic shores, and also in Peru some 2,000 miles away. Now a tree covering such a large area one would expect to find various types and variations, and such is the case. Anyone who has travelled in the Malay States, in passing through a rubber estate must have been struck by the very great differences shown by different trees. Some will be of an erect habit, whilst others will be the opposite, *i.e.*, of a drooping habit, intermediate forms and leaf variation is of constant occurrence. It is true that some of these forms may be different species; be that as it may, we do know that *Hevea Brasiliensis* is a very variable plant, and herein, I think, we have the clue to its marvellous adaptation to its environment, for not only will it grow well on good soil, but I have seen it grow well in ground that at a foot deep was almost pure sand. Again, too, there is a famous tree in the Penang Gardens, of which we have recorded data of yield for a longer period than any tree in Malaya. This tree, although planted on a dry, stony bank, has continued for the past sixteen years to yield an average of 1½ lbs. yearly, and this from only a slight tapping generally of about a month's duration (photo shown).

From these facts it will be seen how tolerant the Para rubber tree is as to soil. I do not mean, of course, that really good rich soil is not the best for rubber; but what I do say is that of the three essential requirements, *i.e.*, heat, moisture and soil, a sufficient and equable distribution of the two former is of the greatest importance. In connection with this question of soils, we all know the marvellous growth of *Hevea* in what is known as the "coast lands" of certain parts in the Malay States; how that age for age, that is say a tree of three years old planted in these deep rich soils compares with a tree of similar age planted in the laterity soil, which may be termed the predominating soil of the Peninsula, how that the former immensely outrivals it in growth, the rapidity of which is almost phenomenal. But, gentlemen, there is a law in Nature which I might say resents this; that is to say that in a highly rich and stimulating soil the cellular tissue is of a larger and looser texture, and approaches the abnormal, compared to the slower and firmer tissue of normal growth. The consequence of this will possibly be a shorter life for the former. We have an analogous case in the life of the native people of the Peninsula; there it is not infrequent for say a girl of fourteen or fifteen to be a fully developed woman, and at thirty to forty to be prematurely old. So I think that the owners of estates who do not enjoy the favoured zone of these rich Coast lands, may hope that what they lose in the beginning will be made up in the end by a longer vitality of their trees. A few words might here be said with reference to manuring *Hevea* trees. In the great rush for land for planting purposes during

the boom, all sorts of land—good, bad and indifferent—were utilised for turning into rubber estates. Even the abandoned tracts of Lalang that had hitherto been considered beyond the pale of cultivation impoverished as they had been by Chinese formerly, taking several crops of gambier and pepper and then abandoning them to Lalang grass even these have been largely taken up for planting *Hevea*. It is hardly necessary to point out, however, that the successful cultivation of any crop, including Para rubber, on any but the very richest soil cannot go on indefinitely without manure of some sort. The poorer the soil the quicker this necessity will be felt. The relative closeness of planting is also a factor which must be considered as to the time for the application of manure. Some of those earlier estates, which were planted 10 by 10, with the original idea of using every alternate tree as a catch crop and tapping them to the fullest capacity as early as possible, and eventually cutting them out (which, alas, was never done), will feel the necessity first. Here the ground is a network of roots interlacing and devouring every particle of plant food in the soil, which if not compensated for in some way will be quickly followed by disaster. Fortunately, so far as Malaya is concerned there is near by in the newly acquired Protectorate of Kedah, large deposits of a local form of guano ; this, if mixed with a proportion of the crushed seeds of the *Hevea*, of which there will be enormous quantities on all the older estates by now, would seem to form an ideal plant food, giving back to the soil what has been taken from it plus the salts of ammonia contained in the guano ; this with the humus derived from the fall of the leaves during the wintering period will probably be sufficient for all ordinary purposes. In very poor soils it will doubtless be necessary to hoe in some leguminous plants to supply nitrogenous matter ; but ordinarily the former ought to be sufficient. The question of clean weeding or not clean weeding is intimately connected with that of manuring. Less than a week ago I was discussing this point with one of our most experienced planters, and he assured me that the experiments he had actually carried out on his own estate proved to him the benefit of clean weeding. I entertain the highest regard for his opinion and I cannot gainsay the facts of his experiments, and yet I am of opinion that having regard to the heavy cost of clean weeding a great deal too much is made of its value to the trees. If we have one case for clean weeding, we also can say a word against it. I have seen *Hevea* growing in tapioca, with no appreciably bad results. I know how trees that have been left to themselves practically abandoned, and have had to fight for their existence, have come out triumphant. The fact is that the tree has such a wonderful vitality, that a few weeds more or less, provided they are only surface feeding, affect the health of the tree very little indeed. It seems to me that turning in the surface growth by periodical chankollings is about as good a thing as one can do, and without it can be shown on the one hand the immense benefit of clean weeding to the health of the trees, and conversely the bad effects by not doing so, then I say the very heavy costs of the system is not justified. This is a controversial point and it will be interesting to hear the experiences of any planters that are present.

As regards planting, I do not think I can add much to the methods at present in use, especially where the usual routine of felling the jungle and burning is adopted. There are those who advocate planting in lines cut through the jungle, thus treating the *Hevea* more as a forest tree than when the whole jungle is cut down and nothing but *Hevea* replaces it. The only advantage this system has in my opinion is that

the balance of nature is not so much disturbed and that it is a better protection against the attack of fungoid and insect pests, and also possibly fire. These advantages, however, can be obtained by dividing the estates into blocks of, say, ten acres, and leaving belts of jungle dividing every ten blocks or so. Planters of the present day have not the same difficulty as regards the supply of seeds as the earlier ones had, consequently now one of the first duties in opening a new estate would be the formation of the nursery, so that the young plants would be coming on whilst the ground was being prepared for their reception. Otherwise, I think too little attention has been given to the advantages of sowing at stake or in situ. I have known trees raised from seeds sown in situ showing no appreciable difference as regards growth to those planted from nurseries, and if that is true all must see at once the advantage as regards cost. Moreover, too, the advantage of leaving trees whose roots have not been damaged by transplanting removes a source of danger in the attack of white ants as it is known that generally the ingress of the termite is at the point of injury.

With regard to the question as to whether white ants attack living tissue, I think that the majority of planters agree that *Termes Geströi* certainly does. I myself in the early days was sceptical on the point, but am so no longer. I should not have referred to this point had I not heard the opinion expressed in this hall by a gentleman whose opinion I value that in his experience he had never met with a genuine case of attack except where there had been a wound. With regard to insect and fungus pests generally, notwithstanding the dreaded *Fomes*, the Brown root disease, die-back, and others, I think agriculturists may congratulate themselves that they are no worse, for where the balance of nature has been so disturbed as in Malaya, and where millions of one kind of tree has been planted gregariously, past experience teaches us that it is only natural to expect attacks of pests, both fungoid and insects. I think we can justly allow these thoughts not to unduly trouble us too much for never before in the history of agriculture, especially tropical agriculture, has there been such a keen appreciation of the necessity of keeping the greatest possible vigilance to prevent the outbreak of any threatened danger by stamping it out at all costs at the very first signs of its appearance, nor have the means for detecting these insidious enemies ever been so efficient as they are to-day. Not only have the Government appointed qualified officials, but the planters themselves recognise that they too ought to supplement the Government efforts, by having mycolagists and entomologists of their own. Thus, while each of the above diseases mentioned might in themselves ruin the whole Rubber industry if left to themselves, the ceaseless and unsleeping vigilance of the planters themselves, aided by their scientific assistants, is it is hoped sufficient to keep them in check. With regard to tapping the researches of Messrs. Ridley and Derry are full of interest, and I would refer any one who has not read them to a careful perusal of their observations. As, however, they are perhaps more directed to yields of latex under different conditions, I would rather here refer to the different forms of tapping. Gallagher, in a most interesting lecture before the Planters' Association in the Federated Malay States, discusses this subject with great skill. He shows the great importance of having a physiological knowledge of tree growth and its direct bearing on tapping. Individual planters will have their own particular forms of tapping, some one way and some another. For my own part, I think the half-herringbone is as good as most others for the reason that it is perhaps better adapted for dividing

the tree into four parts than any other except perhaps the V-shape. In any case, however, the essential factors governing tapping are first to get the maximum amount of latex at the expense of the least amount of bark. Secondly, that in cutting away the bark during the process of tapping we are doing an injury to the tree physiologically speaking, that calls for an effort on the tree to repair that injury, hence severe tapping is not only bad in the sense of putting too great a strain on the recuperative power, but it is also bad from the fact that it does not divide the yield of the tree equally from a labour point of view. Speaking generally, it is now becoming more apparent that we have hitherto underestimated the recuperative power of renewed bark for yielding latex of the same richness in caoutchouc as the original bark. Whilst it is true that trees planted widely apart in favoured soils may renew their bark more quickly and be ready for tapping again in from two to three years, the trees on most estates, especially so those that are planted closely, will require about four years. The advantage of only tapping one-fourth of the bark area each year will be apparent. The coolies in tapping will have straightforward work, especially if it is arranged that the amount of bark to be removed will last the coolie one year. Of course, this will depend on whether daily tapping or alternate days tapping is adopted. It is almost a platitude to say that too much stress cannot be laid on the importance of careful and uniform tapping—by that I mean that the cambium layer should not be penetrated, because the more the cambium is injured, not only is the tree wounded, but the power for healing the wound is impaired. Messrs. Lock and Kelway Bamber have shown that there is not much individual difference in the amount of dry rubber produced by trees that are tapped daily or at intervals of several days, so that it would seem to point to daily tappings on one quarter of the tree as being the best system to adopt. Regarding the question of yields and cost, up to the present there is one outstanding fact as regards the former, *viz.*, that in practically every case the estimated yields have been largely exceeded. This is explained by two chief reasons, the first being that when the question was asked in the early days as to what return planters would get the Department to which I had the honour to belong (and, which I may add was the sole authority in the Straits on all questions connected with rubber for some years after the inception of the industry) replied that about half a pound of dry rubber could be relied on when the trees were about five years old. This amount would go on increasing year by year until about 3 lbs. might be reckoned. This answer was deliberate, and was mentioned with the object of not raising too sanguine hopes. The second cause for the increase over estimates is partly due to what is known as wound response, and which was not so well understood in the early days as is the case now. The question of cost is naturally one that, owing to various causes, will be a variable one, but I think if we put it down at, say, 1s. 6d. per lb., we shall be about right. Certainly we shall be on the side of overestimation than under. From what I could learn when I was recently in South America the cost per lb. to bring to market was about double that figure, say, 3s. per lb., with, of course, the same allowance for variability owing to circumstances.

Now, gentlemen, I think I have glanced at most of the points mentioned in the syllabus, very imperfectly, I admit, but as I have already given my reasons for this at the commencement of my paper I will say no more on this head but finish my remarks by a brief summary.

1. That owing to the great variability of *Hevea brasiliensis* there are many forms in the East—whether these are all of one species is doubtful—and there is much work to be done in noting the difference (if any) in yield of latex of the various varieties.

2. Of the three essential factors in the cultivation of *Hevea brasiliensis*, *viz.*, heat, moisture and soil, the two former are relatively of the greater importance. Also, although the growth of *Hevea* on the rich soils of the coast in Malaya has been phenomenal, it is possible that their life cycle will not be so long as trees grown on a less stimulating soil.

3. The necessity for manuring, and an ideally good manure suggested by utilising the large deposits of guano which is found in the State of Kedah.

4. That clean weeding to be justifiable as regards its cost requires the strongest evidence to support it.

5. Although there are many and serious diseases attacking rubber the means for dealing with them promptly is recognised, and the co-operation of the planters and the scientific staffs should allay any fears on that ground.

6. That the time required for recuperation for the elaboration of caoutchouc in the latex after the original bark has been removed is not sufficiently recognised.

7. The approximate cost per lb. of rubber placed on the London market from the East may be put at 1s. 6d., as against nearly double that sum from South America.

With these few remarks I conclude by asking any planters present to give us their experiences on any of the points raised, or any points connected with this subject, and I shall be glad to reply to any questions to the best of my ability.

Some of the Constituents of *Parthenium Argentatum* (Gray). The Shrub from which comes the so-called "Guayule Rubber."

By Dr. PAUL ALEXANDER, Charlottenburg.

Summary.

1. *Parthenium Argentatum*, the plant from which Guayule-rubber is obtained, is the only plant of the *Compositæ* which contains india-rubber in sufficient quantity for technical utilisation.

2. *Parthenium Argentatum* is the only caoutchouc-plant the bark of which contains *essential oil* as well as india-rubber.

3. The technical india-rubber, prepared from *Parthenium Argentatum*, has the properties of a typical india-rubber.

4. *Parthenium Argentatum* contains 8–10% of india-rubber figured on the total weight; which is more than any other caoutchouc-bearing plant contains.

5. *Parthenium Argentatum* contains about 6·5% of matters soluble in acetone. Most of these (about 90%) can be hydrolysed (saponified). From the acetone-soluble matter could be prepared an acid like cinnamic acid, melting at 119°, an acid $C_8H_8O_2$ (phenylacetic acid?), fusing at 79°, and a compound $C_{15}H_{24}O$, fusing at 127–128°, which is probably a sesquiterpene-alcohol.

6. *Parthenium Argentatum* contains about 0·5% of essential oil. Essential oil, prepared by distillation with steam from Guayule-plants not too long stored, was found to be free from oxygen. This oil contained 50–60% of Pinene and with this 20–30% of a hydrocarbon $(C_5H_8)_n$, boiling at between 130–140°, a pressure of 17–18 mm., which probably is a sesquiterpene. This sesquiterpene is the cause of the typical smell of Guayule-oil.

7. Neither from the essential oil nor from the acetone-soluble matters of the plant or of the technical Guayule-rubber could be prepared compounds, indicating genetic relations between the essential oil and the caoutchouc-matter.

8. The quality of the technical Guayule-rubber deteriorates as the quantity of essential oil increases. For this reason it is necessary to be careful to eliminate, during the preparation of Guayule-rubber, all the essential oil.

9. For the elimination of the essential oil all methods used for the production of Guayule-rubber are suitable in which the plant-material, containing the india-rubber, or the fine distributed india-rubber-matter, separated from the plant-material is boiled for a sufficient time with water or watery solutions.

Parthenium Argentatum (Gray), a dwarf shrub of Mexico, belonging to the plant-family of *Compositæ* and botanically related to the German Camomile, has, since 1900, gained a practical as well as theoretical importance as a rubber-suppling plant. It has long been known that the *Compositæ*, for example the *Leontodon Taraxacum*, or dandelion, which is to be found almost everywhere growing as a weed, yields a caoutchouciferous milk, and in a German patent of 1885, a process is described for obtaining rubber from *Sonctius Oleraceous*, a very common thistle. This fact is hardly known, which of itself proves that the patent had not attained any commercial importance. It came, therefore, as a surprise when a plant of the family of the *Compositæ* was found, which contained rubber in technically workable quantity. Indeed, the contents of rubber in *Parthenium Argentatum* is so great that this plant is the richest in yield of all known rubber-bearing plants—the content of pure rubber substance being 8–10%, calculated on the dried plant material, while *Hevea Brasiliensis*, the original plant of Para-rubber, is only a few tenths of one per cent. In an article on the production of rubber from dried rubber-plants*, I have demonstrated this fact by figures, and will here only refer to the results. The reason for the relative richness of rubber in *Parthenium Argentatum* is that in all rubber-supplying plants, *Parthenium Argentatum* included, the latex-bearing cells are found exclusively in the bark tissue. With a dwarf-tree like *Parthenium Argentatum*, the proportion of bark-tissue to the bulk of the plant is considerably greater than in other rubber plants, and especially so when compared with the giant trees from which Para-rubber is obtained in the virgin forests of Brazil.

Parthenium Argentatum is not, however, the only plant of the *Compositæ* which is of interest as a plant that supplies rubber in technical workable quantities. It holds, however, an exceptional position amongst all rubber plants, as its bark-tissue contains also, besides rubber, volatile oils. Since the caoutchouc hydrocarbon forms during dry distillation, compounds which are also contained in volatile oils, or can be obtained from them, it appeared possible that an examination of the volatile oils of *Parthenium Argentatum* would lead to results from which generic relations could be inferred between the volatile oil contained in the bark tissue and the hydrocarbon of this particular rubber. Starting from this point, I made, several years ago, an examination of the volatile oil and other constituents of *Parthenium Argentatum*, the results of which I will briefly report.

My examination, partly carried out in company with Mr. Kai Bing, dealt with three products :

(1) The rubber known in commerce by the name of Guayule rubber.
(2) The substance which can be extracted by means of acetone from *Parthenium Argentatum*.
(3) The volatile oil which can be procured from the pounded material by distillation.

I.—Guayule Rubber.

I had the opportunity of examining a portion of the first sample of Guayule rubber imported into Germany and reported the results in

* "Der Tropenpflauzer," 12th volume 12, page 57. "Gummi Zeitung," 22th volume 25, page 604.

1904.* Later, I had plenty produced by myself at my disposal. In the works of Messrs. Max Fränkel & Runge (at Spandau), which are under my management, 1,300 tons of Guayule wood was worked between 1905 and 1907 for rubber. The average weight of a single Guayule plant is, in the dried state, about 250 grammes, therefore, 1,300 tons represent more than 5,000,000 plants. Amongst these five million plants, the one before me, measuring about 60 cm. ($23\frac{3}{4}$ inches) in height, with a trunk 28 cm. (or 11 inches) in circumference, and weighing about 1,200 grammes, is the largest I have found. It is at once evident that with plants of such dimensions the usual tapping methods are not practicable; for even, if labour cost almost nothing, which is by no means the case in Mexico, the original home of the Guayule plant, it would not be possible to produce rubber in large quantities through tapping of such dwarf trees. For this reason rubber is obtained from the Guayule plant as follows: The plant is usually pulled up by the root, then dried, then finally ground, and as you have the opportunity of seeing at the Exhibition, either subjected to mechanical treatment or boiled with concentrated alkali. In both cases the rubber which had already coagulated during the drying of the plant, leaves the mechanically or chemically disintegrated plant cells and combines into a larger rubber mass, which is then packed in sacks in the wet state and this represents the commercial rubber. The different kinds of Guayule rubber now on the market, differ only in the content of water, varying from about 15 to 35%. There is further a difference in the amount of mechanical contamination. These contaminations consist, in Guayule rubber, almost exclusively of fine wood particles retained in the rubber mass.

In the beginning the Guayule rubber met with great distrust on the part of the manufacturer. Even so late as 1903, as great an authority as Carl Otto Weber† warned against the use of reclaimed rubber "adulterated" with Guayule rubber. I doubt if notable quantities of reclaimed rubber mixed with Guayule rubber ever came on the market. In any case, Guayule rubber at the time when Weber wrote this article, commanded, or reached a few months later, a commercial value which far surpassed that of the medium kinds of reclaimed rubber. At first, moreover, people doubted whether Guayule rubber really contained real rubber substance. However, in 1904, I proved that the Guayule rubber then on the market contained, calculated on water-free material, about 75% of the hydrocarbon $(C_5H_8)_n$, and that this hydrocarbon behaved in all respects in the same manner as the hydrocarbon of other kinds of raw rubber.‡ In the course of later studies, I obtained by elementary analysis, from carefully cleaned Guayule rubber, still better figures, agreeing with the formulæ $C_{10}H_{16}$. Two combustions, for instance, gave 87·43 and 88·15% C and 12·64–12·27% H respectively, while $(C_5H_8)_n$ works out to 88·28% C and 11·72% H. No one doubts now, that in Guayule rubber we have a raw rubber kind which differs no more decidedly from Para rubber—the typical raw rubber—than other rubbers of medium quality.

II.—The Acetone Extract.

Guayule rubber as it comes to the market, contains 12 to 25% of substances soluble in acetone, calculated on the dry substance. Since it

* "Gummi Zeitung," Vol. 18, page 867.

† "Gummi Zeitung," Vol. 18, page 83.

‡ "Gummi Zeitung," Vol. 18, page 867.

is not always apparent whether the rubber has been obtained by mechanical means or by the alkali process, and since, by the alkali process, the resinous substances are partly saponified, it follows that the nature of the resinous substances can only be ascertained by studying the acetone extract of the Guayule wood itself. By continuous extraction of large quantities of the plant material, I obtained a dark-green extract of the consistency of honey, from which, on standing, colourless crystalline substances separated. The total quantity of the extract was about 6½% of the original material. This extract was then formed into balls, with clean sand, and these were then extracted, first with petroleum ether, then with ether, and lastly with 90% alcohol; 54% of the total extract was dissolved by the petroleum ether; 31% by the ether, and the remaining 15% was completely soluble in alcohol. All these extracts contain plenty of chlorophyll and are thus coloured dark green. The residue from the petroleum ether extract is very soft; the other extracts yielded firmer residues, especially the alcohol extract. An attempt was now made to divide these extracts into saponifiable and non-saponifiable parts, and it was found that by far the greater part of the extracts are saponifiable. The petroleum-ether extract yielded 12·1% unsaponifiable matter; the ether extract 7%, and the alcohol extract 2% figured on the total extracted matter. Attempts at obtaining analytically pure specimens of the acids contained in the extract, have not yet been brought to a close. So far I have obtained, analytically pure, an acid melting at 119°, which crystallizes from water, which, like the other acids isolated from the extracts, undergoes change very easily. Notwithstanding the fact that large quantities of the acid are contained in the extract, I did not succeed in obtaining larger quantities in a sufficiently pure state. Certain observations, into which I cannot enter more fully at present, indicate that the acid melting at 119° belongs among the cinnamic acids. The presence of a compound of the order of cinnamic acids in the unaltered Guayule resin is, moreover, rendered probable by the fact that from the acetone extract obtained from Guayule rubber made by the alkali process, an acid can be isolated in not insignificant quantities crystallizing in small needles, which after being twice re-crystallized from ether, melt at 79°, and which gave by elementary analysis, 69·47 and 69·74% carbon, and 6·80 and 6·75% hydrogen. Theory requires for $C_8H_8O_2$—70·59% carbon and 5·89% hydrogen. I believe that this acid might be identified as phenylacetic acid. If the acetone extract obtained from the wood is distilled with steam there first pass off the hydrocarbons composing the volatile oils; but on protracted treatment with steam, beautiful colourless needles separate in the condensers. These needles have an agreeable aromatic odour which reminds one of camphor. They melt at 127° to 128°, and after being purified by re-crystallization from petroleum ether, give the following analytical results pointing to the formula: $C_{15}H_{24}O$—found: Carbon, 80·49, 80·30, 80·92%; hydrogen, 11·08, 11·51, 11·19%; Calculated: Carbon, 81·08, hydrogen, 10·91%. The substance is, then, probably Sesquiterpenalcohol. On standing it changes into oily substances.

III.—Volatile Oil.

For reasons stated at the beginning of this paper, I have most thoroughly examined the volatile oil obtained from *Parthenium Argentatum* by distillation with steam. For the first distilling experiments I

used 2 or 3 kilos. of wood, and obtained thereby a yield of 0·4%. By the employment of more efficient methods, larger quantities could doubtless be obtained. At any rate, the Guayule plant contains at least 0·5% volatile oil. I myself obtained, on a fairly large scale, using 500 kilos. of wood, considerably smaller yields, for I had not the necessary apparatus for such experiments at my disposal. I have distilled with steam in all, 3,000 kilos. of Guayule wood, and obtained thereby about 3 kilos. of volatile oil, representing a yield of about 0·1%. The volatile oil of Guayule is a greenish yellow, oily fluid, with a peculiar odour, suggesting that of pepper. It has a specific gravity of 0·8861 at 15°, and is weakly laevo-rotary. Analysis shows that the oil consists exclusively of carbon and hydrogen, for it yields almost exactly 87% carbon and 13% hydrogen. On fractional distillation under reduced pressure, *i.e.*, at 17 mm., 30% of the oil passed over between 50° and 60°; 20·3% between 60° and 80°, and 24·8% between 120 and 160°, leaving 5·5% of a resinous substance. On renewed fractionation of the portion coming over between 50° and 60° under a pressure of 17 mm., it was found that the greater part passed over at between 57° and 58°. This fraction boiled under a pressure of 760 mm. at 155° to 157°. It is a perfectly colourless, mobile fluid of a faint turpentine-like smell. The specific gravity is 0·8602 at 16°. It is faintly laevo-rotary ($^{d}_{D}{}^{16}$ =— 3° 22′ in 100 mm. tube). The index of refraction (nD^{16}) is 1·478. By elementary analysis, figures were obtained agreeing with the formula $C_{10}H_{16}$ were obtained (found: Carbon, 87·09, 87·22, 88·01%; hydrogen, 12·35, 12·83, 12·66%; calculated: carbon, 88·23, hydrogen, 11·77%). The physical characteristics of this hydrocarbon indicate pinene, and this supposition was confirmed by converting it into Pinennitrosochlorid (melting point 100–102° with decomposition), Pinennitrobenzylamin (melting point 122°), and Pinennitrolpiperylemin (melting point 128°) which were proved identical with those obtained from turpentine oil.

Returning again to the results of the first fractionation, it will be seen that besides the given fraction, a compound must be present in the oil having a considerably higher boiling point than pinene, as shown by the existence of a fraction passing over between 130° and 140°. This fraction is a strongly yellow coloured thick liquid, having an intensely strong odour of pepper, and must be regarded as the constituent which gives the characteristic smell to Guayule oil. Its specific gravity is 0·9349 at 15°. It shows considerably higher optical activity than the pinene fraction [($^{d}D^{16}$) in 100 mm. tube = —21° 24′, $n_d{}^{16}$ = 1·496]. Analysed by combustion in a closed tube, I found carbon 88·15% and hydrogen 12·58%,* figures which conform closely to the formula $(C_5H_8)_n$ (carbon 88·23%, hydrogen 11·77%). I think it probable that this substance is *Sesquiterpene* $C_{15}H_{24}$, but attempts to identify it with one of the known sesquiterpenes resulted negatively.

The experiments that led to the results just described were made in 1907. In extracting the volatile oils, plants were used which had been shipped directly from Mexico and which had probably been collected and dried very shortly before shipment. Two years later I tried to extract further quantities of volatile oil from newly-obtained plant material, which I had good reason to believe had been shipped to Europe some time (probably several years) before, and afterwards stored. This wood also remained in our works, after being ground, for several weeks,

* 0·1435 grms. Substance gave 0·1625 grms. H_2O and 0·4638 grms. CO_2.

before it was subjected to distillation by steam. Examination of the newly obtained oil now showed that the storage of the wood for several years had wrought considerable change in the volatile oil. Smell and appearance were essentially the same, as in the oils obtained two years before, but a decided difference was noticed in the analysis of the raw oil, which was found to have taken up considerable oxygen. The fractionation took, in consequence, another course. The pinene fraction was obtained the same and in the same quantities as in former experiments. But I could no longer obtain, under a pressure of 25 mm., the fraction passing over at above 100°. In the former fractionation, after distilling off the pinene fraction, the temperature rose quickly to the boiling point of the sesquiterpene fraction and remained constant within 10° until about 22% of the raw oil had passed over, but in fractioning the more recently prepared oil the temperature, after distilling off the pinene fraction, rose without interruption to the decomposition point of the residual resin, and during this time only very small quantities passed over. The residue which formerly had not decomposed under reduced pressure, and which had constituted only 5½% of the weight of the raw oil used, now amounted to almost 50%, and could not be distilled without decomposition, even under a pressure of 25 mm. This residue proved to be rich in oxygen, as shown already by the analysis of the raw oil. The observed effects are not then due to increased polymerization of the hydrocarbon, but rather to its conversion into a resin by oxidation.

Dr. J. Helle, of Brünn, a well-known expert in perfume chemistry, drew my attention to the fact that the smell of the oil points to the presence of styrol. Styrol is a hydrocarbon, boiling at 145·5° to 146°, under pressure of 760 mm., resulting from the treatment of cinnamic acid and cinnamic acid derivates with steam. Its presence in the volatile oil of *Parthenium Argentatum* would, therefore, tally very well with the fact that in the acetone soluble portion of the Guayule wood compounds have been found which are probably cinnamic acid derivates. Now, if styrol were contained in the volatile oil, it should be found in the first runnings of the pinene fraction. I have attempted, by repeated distillations, to separate a component passing over at or near the boiling point of styrol, and have obtained a very small quantity, and I could not identify it as styrol. It showed, rather, the characteristics of the pinene. If, then, there is any styrol in the volatile oils of *Parthenium Argentatum*, it is a very small amount.

The interesting question may be raised whether generic relations exist between the volatile oil contained in *Parthenium Argentatum* and the rubber which exists there side by side with it, but the reply must be that for such relations no proofs can be furnished. The characteristic component of the Guayule shrub is typical rubber substance, with all its peculiarities and the volatile oil strongly resembles the volatile oil from its nearest botanical relation—the German camomile.

For the rubber manufacturer the presence of this volatile oil has a not inconsiderable importance, for it interferes with the usefulness of Guayule rubber. The peculiar aromatic smell clings very tenaceously to the rubber goods manufactured from Guayule rubber, and this is considered a disadvantage. This fact is, however, of minor importance. Far more important is the circumstance that the low boiling portion of the volatile oil, if present in large quantities, causes difficulties in vulcanization, and these difficulties have been the greatest hindrance to

the technical use of Guayule rubber. In perfecting the method of production, we have learned how these difficulties may be overcome, though, as pointed out in trade journals of late, the causes of these difficulties have not yet been clearly apprehended. In this connection, it is worthy of note, that Guayule rubber could not be employed in manufacture until the alkali process had been evolved, *i.e.*, a process requiring a protracted heating of the shrub with water or an aqueous solution. When the old stock of the Guayule plant have been used up, we shall be, at least, principally dependent upon very young plant material. It will then be still more necessary to be careful in removing the volatile oil, either before or after the separation of the rubber, for it may be confidently predicted that in young plants the ratio of rubber to volatile oil will be much less favourable than in old plants. This is the principal reason why Guayule rubber produced from young plants is not only less in quantity, but inferior in quality to that prepared from old plants. Treatment of the plant material with steam, or boiling it with water, is the most convenient and sure method of separating the volatile oil from the rubber substance. It is immaterial whether the shrub itself, or the rubber separated from the plant, is so treated, but in the latter case, the rubber must not be in large masses as the steam cannot, in this case, remove the volatile oil completely.

CHAPTER III.—SECTION II.

(I.) HERMANN C. T. GARDNER.—"On the Physical Constitution of Caoutchouc-Bearing Latices and the Relation of the so-called 'Coagulation' Thereto."

(II.) H. S. SMITH.—"The Centrifugalisation of Rubber Latex."

(III.) WILHELM PAHL.—"The Discovery of the Para Reagent."

(IV.) MISS A. T. BORROWMAN.—"Viscosity of *Hevea* Latex at Various Dilutions."

(V.) WERNER ESCH.—"Some Remarks on the Preservation of Rubber and on the Preparation of Plantation Rubber."

(VI.) PHILIP SCHIDROWITZ and A. H. GOLDSBROUGH.—"The Viscosity of Rubber and its Solutions."

(VII.) CLAYTON BEADLE and HENRY P. STEVENS.—"Raw Rubber Testing."

On the Physical Constitution of Caoutchouc-Bearing Latices and the Relation of the so-called "Coagulation" thereto.

By HERMANN C. T. GARDNER, F.C.S., M.P.S.

The subject which I am about to introduce to your notice does not require an apology for its consideration, since the phenomenon commonly called "coagulation" is of necessity regulated, from the scientific point of view, by the conception entertained of the manner in which rubber-containing latices are physically constituted. Moreover, the phenomenon is not of scientific interest alone, but of the greatest possible commercial significance, and hence an enquiry into the actual cause, or causes, contributing to its production cannot be without importance.

It is my intention to show that segregation and aggregation of the rubber globules, whether the result of naturally occurring processes or the outcome of intention, is fundamentally a physical process, and not a chemical one, and I shall attempt to prove this by such inferences as may logically be deduced from analogously constituted fluids, supported by such evidence as the practical production of the phenomenon affords.

Referring for a moment to the chemical composition of the latex and setting aside small variations due to differences of source, it will be recalled that in addition to the rubber, albuminous and resinous substances, certain sugars, mineral and organic salts, traces of essential oil are found together with water and certain euzymes. The caoutchouc itself exists in the latex in the form of minute globules refractile to light. The opacity of the latex is mainly due to the distribution in it of these particles, since on their removal the matrix becomes translucent. Although themselves not opaque, yet by their presence in abundance, obscurity results through their refracting and reflecting light beams.

The nature and occurrence of the albuminous substances and resins is more complex. The former are no doubt present in solution as coagulable albumins, possibly as mucins, as suggested by Spence; the latter, whether in solution or otherwise, I am unable to say. The other constituents, for the purposes of this enquiry, may be neglected.

The microscope proves the caoutchouc to exist as small ovoid or tear-shaped masses, and Henri has shown these vary in size in latices of the same kind and are of different magnitudes in latices of different kinds, the largest globules of *Funtumia* being to the largest globules of *Hevea* as 5 to 2. Probably the size of these globules is regulated by the internal diameter of the lacticiferous tubes of the tree and their shape by their passage to and fro in the tubes as the "flow" movement of the latex takes place.

There are, then, distributed in the serum, solid particles of matter which remain so distributed for varying lengths of time according to the kind of latex and its nature. Doubtless these globules, of varying magnitudes, are intermixed when the latex is drawn from the tree, although upon its standing for some time they approach its surface in proportion to their size, the largest appearing nearest the surface, the smallest furthest from it. Since caoutchouc is lighter than water and lighter than the serum in which it is found (its specific gravity being when pure 0·920 at 14° C., the gravities of latices ranging from 0·973 to 0.980), it follows that unless a condition of more or less stable equilibrium were present as the resultant of certain conditions, the caoutchouc would immediately rise to the surface of the latex on its resting undisturbed, which we know is not the case, some latices going for a considerable length of time before the rubber rises to the surface. One deduction only is possible from these facts, which is that the rubber exists in the latex in a state of emulsification. This means that coagulation, or the segregation and aggregation of the caoutchouc particles, virtually resolves itself into de-emulsification, that is, disturbance of the physical equilibrium of the fluid.

Now emulsification is a phenomenon of surface tension, which I need scarcely remark is greater the greater the cohesion of a liquid, but gravitational attraction also plays a part and has to be considered, because, as stated, the caoutchouc is of a different density from that of the medium in which it is found. Were the densities of the two identical, the result would be a permanent equilibrium and no separation of the caoutchouc would occur at all, however long the latex remained at rest. Owing to this difference in densities, accentuated if the latex is not protected from the evaporative influences of the atmosphere on its water, the globules slowly rise to the surface, and also through the influence of mass action they finally agglutinate more or less completely. Once the globules pass within the active range of one another's actions they conjoin for the reason that the force exerted to bring them into proximity is superior to the cohesion of the thin intervening layer of serum, hence breaking down the stability of the complex through the now dominant surface tension. From this point of view it is particularly worthy of note that a more rapid segregation and aggregation of the globules does, in fact, take place if a latex be exposed to atmospheric influences than if not so exposed.

The stability of the state of emulsification depends on the completeness with which the gravitational pull is overcome, and this is effected by reducing the surface tension of the globules by the presence of a circumambient film or some substance, continuous or discontinuous.

Weber has supposed an extremely minute film of albuminous material to surround each rubber particle and assigned as the cause of the separation of the rubber from the latex the conversion of this coagulable proteid into coagulated proteid. Spence has shown that by digesting the latices both of *Hevea Brasiliensis* and *Funtumia Elastica* with trypsin " more than half the proteid of the latex can be afterwards removed without coagulation of the latex taking place." I have, personally, conducted a series of experiments on the latices of *Hevea Brasiliensis*, *Castilloa Elastica* and *Micrandra*, the result of which supports the observations of Spence that coagulation of the caoutchouc is independent of coagulation of the albumins. In my experiments I made use of the physical process of dialysis. Coagulable albumins, such as those found in rubber latices, will not diffuse through a membrane,

but after their conversion into non-coagulable albumins they will diffuse. In view of this fact, I took small quantities of latices slightly diluted with water and converted their albumins by digesting them with a little papaïn—a proteolytic ferment—at a temperature of 50° C. for 24 to 36 hours. The digested fluids were then placed in dialysers, when the colloid caoutchouc remained on the membrane, the converted albumins passing through into the water, in which their presence was demonstrated by a decided xanthoprotëic reaction. The rubber removed and placed in alcohol (absolute) could be (on stirring) distributed throughout it as a fine powder, settling to the bottom on standing because of its greater density; that of the alcohol being 0·794. On filtering off the alcohol, the rubber could be readily kneaded into the usual tenacious mass. Or if placed in acetone for a day or two to remove the resins, the same thing could be produced, though it is worthy of note that on placing *Castilloa* rubber in acetone, agglutination, quickly and automatically, takes place. This proves that the albumins have nothing whatever to do with the phenomenon. This being so, the film around each separate globule, which the state of emulsification demands, must be of some other material, because on digestion of the albumin coagulation of the rubber should at once occur, whereas no apparent change takes place. Such a film, may, however, consist of either liquid or solid particles, obviously extremely minute; that is to say, the film may be composed of particles separated by intervening spaces, though barely conceivable, that is, by a discontinuous film; a supposition supported by the distinctly recognisable presence under the microscope of similar discrete particles in some emulsions, notably Bordeaux mixture. Whether such a film consists of resin particles or of fluid particles of some kind, I am not prepared to conjecture. Accepting, *a priori*, the latex to be an emulsion, we have to look for something therein capable of acting as the emulsifying agent. It is known that albuminous substances can act as such, and it is in this direction the albumins may possibly act. To sum up, the rubber is in a condition of emulsification in the latex, the albumins, whilst probably acting as emulsifying agents, are not concerned in de-emulsification, and each rubber globule is surrounded probably by a discontinuous film of particles either liquid or solid, and the permanence of the physical equilibrium of the latex depends on the viscosity of the emulsifying agent and on the magnitude of the caoutchouc globules, *i.e.*, the smaller their size the greater the viscosity of the latex.

This leads to the important phenomenon of de-emulsification, which depends principally on the production of a negative surface tension by breaking down the continuous or discontinuous film surrounding each caoutchouc globule, and in this fact the whole difficulty of the process lies, since a large reduction of positive surface tension alone is not sufficient.

Alcohol reduces very greatly the surface tension of the mother liquor, and if added in sufficient amount induces surface tension of the opposite kind; its action is purely physical. The action of dilute acids is not to be so readily accounted for. It may be that the resins exist in the latex in the form of unstable compounds, and if particles of these film over the caoutchouc globules, de-emulsification is at once explained by the chemical decomposition of these compounds by the acids, when, of course, negative surface tension will result. That something of this kind may be the case, finds corroboration in the fact that in acid latices, as *Castilloa*, the caoutchouc more quickly rises to the upper part of the

serum when standing than in the case of neutral or slightly alkaline latices as *Hevea*, although the agglutination of the globules may not be so satisfactory.

That the caoutchouc globules undergo no chemical change on de-emulsification by chemical re-agents, is sufficiently shown by the observation that if a little of the rubber coagulum obtained be diffused through benzine and this is afterwards evaporated off, microscopical examination of the rubber film obtained shows it to be composed of masses of globules identical in every respect with the globules in the latex.

Further, that the phenomenon is a purely physical process is demonstrated by the fact that purely physical agencies such as centrifugalisation, passage of an adequate electric current, dilution with water and standing, heat, etc., will produce more or less complete de-emulsification. Dilution needs no further explanation, in view of my remarks on relative densities ; the action of heat can be explained by a violent acceleration in the rate of movement of the globules until the kinetic energy produced becomes sufficiently great to overcome the normal stable equilibrium, and they ascend with the upward heat motion of the fluid particles of the matrix, when being thrown against one another their own mass action is exerted, surface tension is overcome, the emulsified state is destroyed and agglutination commences.

Lastly, how can be explained the prevention of coagulation in some cases on the addition of an excess of acid through causing re-solution of the albumins ? This question is pertinent, having regard to the independence of the phenomenon on the albumins. I believe an answer will most reasonably be found in the supposition that the attraction of the molecules of the surrounding medium on the molecules of the emulsified rubber is not lessened to a sufficient extent to produce a negative surface tension strong enough to completely overcome the positive surface tension of the globules. At the most, such an effect is but temporary, as sooner or later agglutination does occur. There are obviously some phases which are difficult of interpretation, but in the light of such observations as have been made, the theory I have stated appears to be the most rational.

The Chairman : Mr. Gardner has given us a very concise and clear paper which I am sure any of us can follow, on a very difficult subject, and I hope that in the time available we shall have a good discussion.

Dr. Petch : I should like to ask Mr. Gardner as to the action ot ammonia in *Hevea* latex ?

Mr. Clayton Beadle : I should like to know whether he regards the globules as being solid. He refers to them as solid particles of matter. Does he regard them as rigid particles, or as in a condition of semi-solution ? There is a paper to be read on the subject of the viscosity of *Hevea* latex which I think you will see rather points to the probability of the particles being of a liquid nature. Then as to the fact of the proteïn acting as an emulsifier ; it appears to me that if that is the case, to remove the proteïn must act in two ways. It would appear to me to assist de-emulsification by its removal from the solution, or, at least, it would remove the cause which brought about emulsification, and by so doing it might allow de-emulsification to take place. If this is correct, the proteïn, while present, would maintain the condition of emulsification, and its removal might cause reverse action to take place.

Mr. Chisholm: I would like to ask Mr. Gardner why it is that the addition of water to *Funtumia* latex hinders rather than assists coagulation?

Dr. Petch: The addition of water increases the facility with which the latex will coagulate.

Dr. Black: There is one point in the paper with which I do not exactly agree. I understood it to be said that if you take the rubber which you have removed by one of those processes described, then solution it, take off the solvent and examine it under a microscope, the globules are the same as those before you use the solvent. My experience is that after solutioning rubber you will find that the globules are not identical, but have undergone a serious change by the action of the solvent.

Dr. Petch: I shall be glad to know if the proteïns take any part in coagulation, because opinions are flying around as to the weakening of rubber by the action of bacteria on it, and the only thing the ferment can act upon is, obviously, the proteïn. It would seem that the strength of the rubber was not due to the caoutchouc but to the proteïn, because the bacteria must destroy the proteïn, so that on that supposition the biscuit with the most proteïn would be the strongest. Another point on the analysis of rubber—I do not know whether it touches Mr. Gardner's side of the question, but we are building up theories on the other side of the world on minute differences. I should like to know within what percentage limit Mr. Gardner considers the ordinary analysis of rubber correct, and whether you can make any deductions from an analysis which gives you the rubber by difference. The differences in your proteïn are small, and the differences in the resins are also small. I am treating only of *Hevea*, of course, and it seems to me that you take a determination of resin, a determination on ash and then of proteïn, lump them together, and call all the best rubber. We, on the other hand, would regard them as scarcely worth anything, not good enough to base any deductions upon. I hope you see my point. We are trying to get some idea of the quality of the rubber—relations between your physical tests and your analyses. We send samples home and get them analysed, and we get certain returns as to breaking strain and so on, and certain returns of the amount of resin and proteïn. I should like to know to what percentage we are justified in making any deductions from analyses of rubber. And then I should like to know whether we are really getting down in our ordinary analysis to the constituents which we ought to get down to. Cannot we get down to something better than rubber, resins and proteïn? If we could, we could get on with our theory of tapping and rubber in the latex. I may give you an example of the analyses we get. I cut a rubber biscuit in half horizontally, and the determination of moisture, resin and proteïn differed—one was 25 per cent. and the other 16 per cent. If we get differences of that kind between two halves of the same biscuit, we cannot base much theory on our results.

Mr. Clayton Beadle: I think it is pretty well established that it is not so much a matter of the quantity of proteïn as the manner in which it is distributed if it has any effect on the strength of the biscuit. From practical experience I can say that if the rubber is worked and masticated, the strength of the rubber is entirely altered, as also the viscosity of the solution obtained from it. The network structure is

broken up, so much so that if you make solutions of such rubber in benzine, and allow them to stand, the whole of the proteïn is precipitated, and you get a solution, as shown in the previous paper, which is constant in its physical properties.

Mr. Gardner, in reply: One speaker mentions the action of formalin on the latex. Of course, you all know it prevents the coagulation of the albumins, and upholds my contention rather than otherwise. On the other hand, the chemical action of formalin, whether on *Funtumia* or *Hevea* latex, is just the same. The contention of my paper is rather that the de-emulsification is a physical rather than a chemical process. As regards whether it is a necessity in the analysis of rubber to go any further than determine the amount of resins and proteïn and so forth, I do not think it is. All you want to know is how much rubber you have. I quite agree that the strength of the rubber depends on the network of the proteïn in it. With regard to Mr. Clayton Beadle's question as to whether the globules were liquid or solid, although I cannot positively say I am of the opinion from experiments I have carried out, that they are in all probability liquid. Of course, I must ask you to remember that I am advancing theory rather than stating actual facts. I am simply trying to deduce in a logical manner what the constitution of the thing is from such experiments as we have had provided for us.

The Centrifugalisation of Rubber Latex.

By H. S. SMITH, Caledonia, Tobago, B.W.I.

As far back as 1898, Professor Biffin, of Cambridge, discovered that the rubber globules could be separated from the mother liquid by centrifugal force, and much was expected, but very little practical use has been made of the fact up to the present.

It will surprise many planters to hear that for more than five years a centrifugal separating plant has been in use on the Louis d'Or Rubber Plantation, Tobago, for the treatment of *Castilloa* latex.

There are also several estates in Mexico which have been using centrifugal machinery for some time and quite recently these machines have been successfully tried with *Hevea* latex.

During the last three years I have been working at this problem, and although almost all of my experiments have been carried out with *Castilloa* latex, the few which I have made with *Hevea* and *Funtumia* have been successful ; but with these rubbers the addition of armic or acetic acid is necessary in order to obtain a separation.

The difficulty to overcome in treating rubber centrifugally was the fact the separated rubber was of such a solid consistency that it would not flow through pipes and, therefore, would not admit of the ordinary skimming methods of the cream separator or of a continuous inlet and outlet.

After experimenting for some months with a drum without an outlet, it became evident that if after the separation had taken place, the liquid could be thrown out, without stopping the machine, much would be gained, this meant that a valve must be designed capable of being opened and sheet during the rotation of the drum.

This was done and I found that the machine was not only a separator, but a sheeting and drying machine also, for as the liquid was thrown out, the separated rubber fell back on a porous screen fitted to receive it and the rubber dried in the way that clothes, wool, etc., is dried in an ordinary hydro.

The operation is very simple and speedy, after the machine is started enough water is run in to cover the porous screen ; then the latex is run in (after being sieved to remove mechanical impurities), and in about three to five minutes the rubber will separate, the pressure of the liquid in the drum forcing all the rubber into the inner part of the cylinder formed by the latex ; the valves are then opened and the liquid allowed to escape and the separated rubber is deposited on the screen.

With *Castilloa*, at certain times of the year, when the machine is stopped it will be found that the rubber has coagulated and can at once be stripped from the screen ; at other times it will be found that only agglutination has taken place, and although the rubber is dry enough to crack like a piece of cheese, it has to be put into the curing-house for a day or so before coagulation takes place and it can be stripped from the screen.

This question of coagulation and agglutination is a curious and interesting one. At first I thought that the question of coagulation only meant dryness, but it seems to be something more, for I have spun the machine for more than an hour and got the rubber practically bone dry and yet coagulation has not occurred, but the least pressure of working at this stage brings about coagulation.

I have tried many chemical coagulants without success. The only thing suitable seems an extract from the Moon Vine (*Spomœa Bona Nox*) so generally used throughout Mexico and Central America for the coagulation of *Castilloa* latex.

The colour of *Castilloa* rubber seems to me to depend greatly upon a very early separation of the mother liquid from the rubber. Latex spun within a few hours of collection and sprayed with water in the machine, will give an absolutely white rubber, which will not oxidise in the least. Keep the latex twenty-four hours and no amount of washing will produce a white rubber.

In practice, I have not found any advantage in putting a light-coloured rubber on the market, if it is obtained from young *Castilloa*, for centrifugalisation, I regret to say, has been proved by most searching analysis to have no effect upon the resin contents of rubber, and the high percentage of resin contained in all rubber obtained from such young trees makes it weak and unsuitable for any of the better class work where a white rubber is required.

The advantage of this process would seem to be:

(1) Great saving of time and space, since no coagulating tanks or pans are required.

(2) Rubber separated, sheeted and dried in the one operation without being worked on the rolls.

(3) Rapidity of curing, for the sheet of rubber being built up under high centrifugal pressure, and the water forced out during this building up process, the pores remain open and what little moisture remains, quickly dries out in the curing room or during the smoking process.

Demonstrations with *Hevea*, *Castilloa*, and *Funtumia* latex will be given with a small experimental machine in the King George's Hall, this afternoon, acetic acid being used to obtain the separation in case of *Hevea* latex; hot water for *Funtumia* latex. *Castilloa* latex separates without any addition.

Dr. Petch: When I first heard of this method of working *Castilloa*, I thought it was another example of the splendid isolation of our different botanical departments in the tropics, but I found I was wrong, because Mr. Smith does refer to Biffin in 1898. Biffin went out and a company was formed to open up plantations in Mexico. I shall be very glad to know what has become of that company. His paper on the subject is in the "Annals of Botany." The discovery that *Castilloa* latex could be treated by machinery was hailed with considerable satisfaction in Ceylon, and at one time it might possibly have changed the whole course of the planting in Ceylon. Rather fortunately it did not. Parkin at that time was working in Ceylon on *Hevea*, *Castilloa*, and other latices we had there, and made many experiments. Parkin tried to centrifugalise *Hevea* and failed. Wright tried in the same way, and added various coagulants, but he failed also. I think it seems to be demonstrated fully that we cannot get *Hevea* latex coagulated by simply centrifugalising. If you put in an acid of any sort, then I do not see where your machine differs from the machine which has been on the market since 1905. The only point which I think seems to be claimed

as new is probably the valve added to the separator. But we have tried in the Far East various methods, and up to the present they have all been a failure, and it is that which has led me to say that the paper is an example of the isolation of our botanical department. On the other side of the world we do not know what they are doing or what they have done.

Mr. CLAYTON BEADLE: I may mention that there is a man whose name I have forgotten—he hides his light under a bushel—who came to show us a specimen of Para, from the latex of a wild tree, which he asserted—and we have no reason to disbelieve his statement—that he had produced by means of a centrifugal machine. I am qualifying my statement somewhat. I presume we cannot speak for the actual facts, but he declares it is only a matter of centrifugal force, if you get a sufficiently rapid rotation, something very enormous, and a sufficient size of pan.

Dr. PETCH: Parkins' record showed what could be done.

Mr. BEADLE: What did he get—14,000?

Dr. PETCH: I cannot say the exact figure.

Mr. KELWAY BAMBER: We get a revolution of 11,000 a minute.

Mr. GOLLEDGE: In our machine, if you want complete separation, you must put in acids.

Mr. KELWAY BAMBER: We started by washing, and we found it would give a pale-coloured rubber, but on running the thick cream out no coagulation takes place, even after a couple of days, but I found if I put a close composition top on and rolled it very slowly it instantly set the rubber, and the whole thing could be taken off as a pure sheet. With regard to the machine made, the valve is new.

The CHAIRMAN: You did not find that by plain centrifugalisation you could separate *Hevea* latex completely.

Mr. KELWAY BAMBER: Not up to date. I did not try the acid suggested, but I should think that would cause a lumpy separation.

Dr. STEVENS: With regard to the centrifugal process, it is not only a question of speed or revolution, but of circumferential speed. It depends, in other words, not only on the number of revolutions, but on the size of the vessel in which you are bringing about the separation. With regard to the sample Mr. Beadle mentioned, I remember testing it and finding it very acid.

The CHAIRMAN: In using this machine, has any estimate been made of the amount of power required per lb. of rubber produced?

Mr. SMITH: No, we have only applied ourselves to the engineering difficulties to complete the machines. The machine you see on the stall has only just been completed.

Professor CARMODY: In connection with the preparation of rubber from *Hevea* latex, it does not seem to me it makes any difference whether you add acid or not. In the experiments we have made we have never added acetic acid to produce anything more than coagulation. When you induce granulation you should stop, and then you get your *Hevea* rubber separated much more rapidly.

The Discovery of the Para Reagent.

By WILHELM PAHL.

Chemist and Proprietor of the Dortmundu Gummiwarm Fabrik, Dortmund.

The victory of cultivated *Hevea* rubber over natural Para rubber has at last been secured ! The mystery of Para rubber is resolved. The really significant agent in Para coagulation is brought to light, and we are at last in a position to replace the primitive Para coagulation methods by an ideal factory method !

Chemistry has led on to this victory, torn asunder the vail and opened up a wealth of possibilities to *Hevea* planters and to the whole rubber world as well.

The reagent that has made all this possible is *carbonic acid*, and the advantage possessed by planted *Hevea* rubber over Para will be clear to anyone who studies the two methods and balances their advantages against each other. The new product combines all the good points of plantation Hevea and Brazilian Para, and it shall accordingly be called *Hevea Para.*

For many years chemists have striven to find what was the particular agent to which the marvellous results obtained in Para coagulation (by the smoking process) were due. Scientists from the greatest of the civilised nations have bent themselves to this problem. In 1910 no less persons than Drs. Frank and Markwald, of the Dr. Rob. Henriquez Nachfolger Laboratory, busied themselves with this question. With infinite pains they obtained Urikuri palm nuts, such as are used in the forests for smoking Para, and subjected them to a rigorous chemical examination. They found many things, but, unfortunately, they did not discover the right one.

Let us look at the Brazilian method more closely. The latex from which the valuable Para is to be prepared must be coagulated. For this purpose the native collects, first, sticks with which he lights a fire, to which he adds Urikuri palm nuts, when the fire at once develops a thick smoke. Why these nuts are used it is very easy to see : It is simply because :

1. They have an extraordinarily hard, dry wood shell.
2. The kernel is full of oil.

In a tropical forest it is very difficult to find dry wood. Owing to the dampness of the air, most falling wood rots, since most of the trees are rapid growers and therefore soft ; such wood will not burn well. On the other hand, the palm nuts have a hard, dry, free-burning shell, which makes a good body for the fire, which is then maintained by the oil of the kernels. When a hard, dry, wood is burnt we get, as is well known, the

most perfect combustion, the evolved hydrocarbons burning to carbonic dioxide and water. The smoke is a more or less secondary effect—and in this case it simply serves as a *carrier of carbonic acid*—which is, so to speak dragged out into the air by the smoke. Admittedly there are present other substances having a secondary or minor action (such as creosote, glycerine, etc.), but the one significant fact is that the smoke carries carbonic acid—and the action of this carbonic acid charged smoke is not—as some have thought, to "smoke" the already coagulated rubber—but *to coagulate the latex*. It will be remembered that in the smoking process the native pours fresh latex over either the paddle or the film of already coagulated rubber adhering to it. Obviously the latex *must* coagulate instantly, or it would flow back into the containing vessel.

All those who have sought to find what ingredient of the smoke was responsible for this prompt coagulation have been on the wrong track, and, therefore, unsuccessful. *Carbonic acid* alone does the work. The valuable features of smoked Para may be summarised as follows :—

1. Its "nerve."
2. The fact that it contains valuable metallic salts (carbonates), which play such an important part in the subsequent vulcanisation.
3. That it (*i.e.*, the included serum) reacts alkaline.
4. That it never moulds.
5. That it never putrefies.
6. That it never oxidises.
7. That it consists of strongly polymerised rubber molecules.
8. That, as a consequence, it shows extraordinary vulcanisation results.
9. That its solution has a high viscosity which has great technical value.

Hitherto, plantation *Hevea* rubber has not possessed these properties, and this is somewhat surprising, for the tree is exactly the same as that exploited in the forests of Brazil. The Hevea trees came originally from Brazil, and under like tropical conditions and similar soil conditions has had an extraordinarily fruitful growth, particularly at the Straits. Since, now, this tree gives such a valuable product in Brazil, it ought to, and must, give the same quality in its new home, provided the one condition that the latex in the two localities be coagulated under like conditions. On the large scale presented by a modern plantation it seemed, however, impossible to take over this slow mechanical procedure. They, therefore, sought refuge in coagulating agents—which allowed coagulation under factory conditions, but did not give satisfaction. Acetic acid, in particular, worked smoothly, but the product obtained had serious faults, chiefly the following :—

1. The coagulation is too slow, requiring from several hours to an entire day, according to the amount of acid added. If rapid coagulation is desired, it is necessary to use large quantities ; moreover, the rubber coagulated in this way separates as a jelly, which shows that it is not properly polymerised.

2. Acetic acid does not prevent the rubber from moulding in the moist tropical air.

3. The rubber is inferior to Brazilian Para in point of nerve.

4. A very bad point about acetic acid is that by it the metallic salts that are so useful in the subsequent vulcanisation are converted into acetates, and these make the resulting rubber soften in use.

5. When large quantities of acid are used, crystals like sand are found in the rubber, and these are the objectionable acetates above mentioned.

6. The solution made with a rubber thus coagulated has a low viscosity, showing again defective polymerisation.

7. Finally, the rubber has not the value of Para. It is entirely lacking in nerve.

The only reason why plantation *Hevea* rubber has reached at times as high a price as Brazilian Para is not on account of its fine results, but simply that it could be purchased clean and dry with little or no shrinkage while Para shrinks in washing and drying from 18 to 20 per cent.

If this line of work had been kept up with plantation rubber (and hosts of other coagulants have been tried, mostly strong acids), plantation *Hevea* rubber would *always* have remained in the background; but all this has been changed by the discovery of the carbonic acid method of coagulating the latex, the most important discovery for the planter that has been made for decades. Carbonic acid it is that has given Para rubber its superiority hitherto, and by availing ourselves of this knowledge we can coagulate plantation *Hevea* latex in such a way that it yields a product *superior to* Para rubber in quality, purity and strength.

Among the valuable characteristics of this product (designated as "Hevea Para") are the following:—

1. The carbonic acid coagulates the latex *instantly*. The latex is an emulsion of liquid caoutchouc globules coated with vegetable albuminoids. The action of carbonic acid on this system is rapid and decided, and consists in causing the separate globules to come together and cohere. To this is due the strongly polymerised rubber we obtain, a rubber that possesses all the good qualities of Para in that—

2. The nerve, strength, and elasticity are not only equal to but superior to what is met with in case of Para.

3. The metallic salts present are carbonates as a result of the carbonic acid treatment.

4. The rubber is alkaline, for carbonic acid is not destroyed by alkali, but can exist in contact with it, *vide* the well-known alkaline carbonic acid charged mineral waters.

5. The solutions of this rubber have as high viscosity as those of Para, and the product obtained on vulcanisation is the same.

6. Carbonic acid coagulation is the cleanest possible method, and gives the purest and lightest coloured product possible.

7. On the other hand, Para rubber is coloured by the smoking process.

8. "Hevea Para" never moulds, for the carbonic acid removes the plant-albuminoids which form a soil for bacterial vegetation.

9. "Hevea Para" oxidises no more readily than does Brazilian Para.

10. Rubber coagulated by acetic acid soon acquires a bluish surface colour. This is due to the decomposition of residual albuminoids with formation of phenols, which give the rubber its bluish colour, and make it second quality.

11. In the new process we have for the first time a latex coagulated by a gas and not by a corrosive fluid as in case of the strong acids.

12. Briefly, we have here the only reagent which can give plantation *Hevea* rubber the same fine quality as Brazilian Para.

13. Another advantage of carbonic acid is that it requires no fine manipulation. Its use can be intrusted to the most ignorant hands.

Careful weighings and measurings are not required, as they are in the other processes. If the native is disposed to be prodigal, he can use as much as he pleases, for as soon as the instantaneous work of coagulation is over all the rest of the reagent escapes as a non-noxious gas.

14. Carbonic acid is absolutely indifferent toward rubber, and, therefore, does not harm it. It is also the cheapest method. The carefully worked out commercial methods of storing and conveying liquid carbonic dioxide provide the planters with a cheap and important coagulant.

15. The cheapness of carbonic acid is seen when we consider that 2 kilos. can be produced from one kilo. of coke.

16. Carbonic acid is available everywhere owing to the universal consumption of the artificially charged carbonic acid waters.

17. Since this process is of great value for the planter as well as for the entire rubber world, giving, as it does, at one stroke, victory for the plantation product over the forest product, we have patented it in all countries. Any unlicensed use of it will be prosecuted, and any "Hevea Para" prepared by this process by any person, unless under licence, will be confiscated in law.

18. The carbonic acid process alone among all others insures every particle of the latex coming in contact with the coagulant. It is, therefore, an ideal method.

In order to facilitate the use of this coagulation process, three pieces of apparatus have been designed:

1. The first is a small one which permits the coagulation to be carried out by a native labourer in any required place, by simply introducing the carbonic acid and stirring.

2. The second is a small and convenient apparatus which allows the introduction of carbonic acid and the stirring to go on simultaneously. It is especially adapted for use where larger vessels are employed, as is the case in factories.

3. The third is especially designed for handling larger quantities of latex, and is so constructed that the carbonic acid is brought in contact with the smallest particles of the latex, thus constituting an ideal coagulation process.

Analysis will always show when this process has been used, and we thus have the means of protecting our rights, which it goes without saying we shall do!

The CHAIRMAN: We have certainly just listened to an interesting paper. I for my part am not in a position to judge it at present, because the first point that arises in my mind and, I fancy, in the minds of some of you as well, is that while the paper contains a very large number of statements there is very little experimental evidence brought to substantiate them, but that, very likely, may be rectified in the future. However, the fact that evidence is not now at hand does hamper discussion. The situation might remind some of us of the early history of iron smelting. Herr Pahl's statement that carbonic acid is the active coagulating agent in the smoke employed by the Brazilian natives in the treatment of *Hevea* latex reminds one of Sir Lowthian Bell's enunciation of the fundamental reaction of iron smelting, namely, the action of carbon monoxide on ferric oxide with production of metallic iron and carbonic dioxide. All our subsequent knowledge of iron smelting has been built up on that one simple reaction. But are the two cases analogous? and has Herr Pahl discovered the fundamental fact? The coagulation of *Hevea* latex by smoking is a thing that has been before us, of course, for

years, but I confess it is somewhat of a new idea to me that carbonic acid played the essential in it. Another point that occurs to me is that last year, being one of the judges on a certain prize that was offered for the best method of coagulating rubber, I had occasion to examine quite closely the Da Costa process, which consists in passing smoke directly into the latex. Fundamentally, I must confess, I cannot see very much difference. At the same time, I have not had the opportunity since that time of examining the product obtained by that process on a more extensive scale, but the impression on my mind is that ideal results have not been realised by that or by any other process. Another point is that I was under the impression that the identical process carried out in Brazil had been transferred and tried not only in Ceylon, but at the Straits and in various other places with plantation *Hevea*, and there, again, I am not aware, although it may not have come to my notice, that results had been obtained of the ideal character set forth in this paper. Perhaps I may be permitted just a word on two points I noticed as the paper was being read. On the third page, claim No. 8, where it is stated that *Hevea* Para never moulds, for the carbonic acid removes the albuminoids. Of course, this removal would be, for many reasons, advantageous, but I must confess that my mind finds some difficulty in assimilating the statement that they are removed, and I hope some light will be forthcoming. And, finally, point No. 18. I think those of us who are chemists will agree with me that the process whereby a gas is passed into a liquid resulting in the production of a solid which precipitates is not an ideal process for assuring complete contact between the reagent and the substance acted upon. The solubility of carbonic dioxide, at ordinary pressures, is not high, and it appears to me that in this particular case there would be a decided tendency to inclusion and consequent sluggishness of action. This objection can only be answered by experimental data, and that is not yet forthcoming.

Prof. P. Carmody: I am interested to hear of any new coagulant in connection with any latex, and especially with *Hevea*. You have alluded to many points, Mr. Chairman, which I intended to speak about, and it will be unnecessary for me to take up your time by referring to them again, but I would like to remind the meeting—and the point occurred to me this morning when a previous paper was being read—that in speaking of a latex as an emulsion, we may qualify it by saying it is a weak emulsion. Those who have worked with latices have come across the real emulsion, which is different from what we find in the collected latex. It appears to me, then, that this process, which is apparently a chemical process, may be purely a physical one in which the mechanical action of the entering gas brings about agglutination of the rubber globules. I should like to ask the author of the paper whether he has tried any other gases under similar circumstances. In the next place we all know that the smoking process for the coagulation of *Hevea* has been studied in detail, in the lights of the known chemical composition of the smoke. We have tried creosote, acetic acid, etc., either separately or together, but this is the first time I have heard the carbonic acid of the smoke suggested as a coagulating agent. I cannot agree with it. I cannot agree with those who believe that creosote is the important agent; nor do I agree with those who say that acetic acid is. There is something in the smoke which we cannot understand and which we had better leave unexplained. I should like to ask whether the author thinks carbonic acid prepared by laboratory methods is likely to be the same as that

produced by combustion. I should also like to see experimental evidence as to the result of this carbonic acid process. One would have expected specimens of the rubber to have been laid on the table so that we might see whether it was equal to, or superior, to the ordinary Para rubber; and I should also have thought we might have received some figures as to the viscosity test spoken of in connection with the paper. I would also like to ask the author whether it would be successful for latices other than *Hevea*.

Dr. Stevens: This paper, it appears, is intended as an argument to show that carbonic acid, or carbonic dioxide, when used as a coagulant for *Hevea* latex will produce rubber superior in quality to any other method. I am not quite clear whether it is superior to Brazilian Para, but I take it that it is at least equal. So far as I can judge, the only argument behind vague statements in support of this theory is the fact that carbonic acid is formed by the combustion of twigs, nuts, etc., as used in the production of Brazilian Para, and this carbon dioxide is regarded as the essential constituent of the smoke which produces the coagulation of the rubber in Brazil. Now that in the first place is a contentious matter. Whether it is the carbonic acid, or the vapours of acetic acid and other acids which produce the coagulation of Brazilian smoked *Hevea* rubber is an open question. In the next place, I can only repeat the statement of our Chairman, and of the last speaker, that it is quite impossible to arrive at any conclusion as to the alleged superiority of this rubber without samples and without the results of proper vulcanisation tests. I do not think even that samples exposed for view here would be sufficient to show whether or not this rubber coagulated with carbonic acid is or not superior. I think, however, that we should certainly make a trial with carbonic acid. Personally, I cannot see why carbonic acid should yield a better rubber—I do not see any theoretical reason—still we are anxious to try every kind of coagulant. We have tried a large number, but we are always ready to try fresh ones if they are brought along, and I think, therefore, that we should certainly give this one a trial, too, but I must say that the arguments brought forward in this paper are not such as to command much confidence. Many of the statements are seriously open to question. I might point out one or two. The word "nerve" is used very frequently. That is a very ill-defined term, although some people seem to understand what it means. With regard to the value of carbonates in rubber mixings if carbonates are required they can be added subsequently. There is a statement on page 2, third paragraph, that the serum of *Hevea* latex reacts alkaline. That is news to me. I have tested rubbers from Brazil and the East, and in all cases they gave a faint acid reaction. There is, also, a statement that smoked Para rubber never moulds. If you cut up a piece of Para rubber and put it in a bottle and leave it a short time you will find mould growing all over it. I am sorry the lecturer has not been able to give us any figures as to the viscosity. It is stated that the viscosity is high, but the exact bearing of a high viscosity figure is a contentious matter. The lecturer said that coagulation with acetic acid was too slow, requiring from several hours to an entire day. That is not the case, several hours is much longer than required, it does not take so long as that. Then the lecturer says, "If rapid coagulation is desired, the rubber separates as a jelly, which shows that it is not properly polymerised." I do not know what is the author's mind when he uses the word "jelly"—it would not resemble a jelly in the ordinary sense. Again we have the expression "polymerised" a term which is in itself an assumption when applied to

rubber latex. Another point, referring to the use of acid, is stated that the bases are converted into acetates, making the resulting rubber soft. I should like to know how much acetate Dr. Pahl found, say, in pale crepe rubber. My impression is he would not find much, if any. Then surely this is a rather sweeping statement referring to plantation rubber—" it is entirely lacking in nerve." Then with respect to the albuminoids. I should like to hear exactly how they are removed by carbonic acid. With regard to the bluish surface referred to, if coagulation is carried on under proper conditions, there is no bluish surface. As regards the cost of the carbonic acid process, this is an important question from the point of view of the planters, supposing that carbonic acid is found to yield a better rubber than, say, acetic acid. The argument in favour of the former is that 2 kilos of carbonic acid can be produced from one kilo of coke. That is true. The raw material is cheap. But when you come to compress your gas and put it into cylinders, and transport them in a tropical country—many of us know the difficulties of that—it becomes quite another matter. I doubt whether it would be safe to place these cylinders in the hands of a coolie. Then the lecturer says " the carbonic acid process alone amongst all others, ensures every part of the latex coming in contact with the coagulant." I think it would be very difficult to devise a plant in which a gas comes in contact with every particle of a liquid. In the case of acetic acid we are able to make a much better mixing, because we are dealing with a liquid, and we can make a perfect mixture of the two liquids before coagulation commences.

Dr. SANDMANN : I have known Herr Pahl now for several years and am surprised at the confidence with which he makes assertions unsupported by evidence.

If Herr Pahl had himself been in the Amazon district of Brazil and there observed the smoking of the rubber, he would certainly not have asserted to-day that the principal effect is produced by carbonic acid.

In order to produce as much carbonic acid as possible a complete combustion of the material must take place. A smouldering fire, making thick smoke, only produces comparatively little carbonic acid. The *seringuero*, however, avoids, so far as possible, a bright fire. What he desires is a strong, steamy smoke, and he interrupts the smoking of the latex whenever a bright flame appears. His practice, therefore, precludes the production of much carbonic acid, which Mr. Pahl believes produces the principal effect. Without troubling himself about the chemistry of the process, the *seringuero*, on purely empirical grounds, works in in such a way as to produce in the smoke—on dry distillation products—from his Urikuri nuts, Massaranduba wood, or whatever it be, products such as creosote, carbon monoxide, acetic acid, etc., which act not only as coagulants but as preservatives. The latex, being treated in thin layers, is permeated through and through by these distillation products in gas form, and is thus completely sterilized. The coagulation is brought about partly by the acid constituents of the smoke, and partly by the heat of the smoke, a factor which should not be underrated in studying the coagulation process. Not only does it hasten coagulation : it also causes strong contraction of the rubber globules. The *seringuero*, therefore, does not begin smoking latex until the smoke emerges from the *borao* at the right temperature.

The high esteem in which *Hevea* rubber from the Amazon territory is held by manufacturers is due, in my opinion, to the fact that this rubber has been thoroughly sterilized by the smoke, and that the coagula-

tion has been effected partly by acid, and has been rendered rapid by the heat—a most important point. Another factor in this high valuation is the fact that this rubber has been obtained from trees which are 15 to 20 or more years old. The method of tapping, *i.e.*, by means of the *machadinho*, does not permit the tapping of younger trees. On the other hand, the trees which at present yield the plantation rubber comprise a large number which are perhaps 8 years old, but the majority of them are only 5 to 6 years old.

When plantation rubber is obtained from trees 15 and 20 years old, without being intermixed with latex from younger trees; when it is acknowledged that sterilization of the latex and quick coagulation are the indispensable conditions for producing good rubber; and when the treatment of the latex is carried out on these principles—the produce of the plantations will be as good as that from the forests of Brazil.

I shall say nothing at this time on the question of the best coagulant, for it would appear as if I were advertising my own work, but I do wish to express my conviction that carbonic dioxide is not a suitable one and that quite as good results would be obtained by simply injecting hot air into the latex.

Dr. Huber: Some of the objections I have to make have already been made. I have only to add that really the intention of the Brazilian native is simply to produce smoke. If he has produced smoke for some time and the nuts continue to burn without giving a good smoke, then the coagulation does not continue in the same way. He has to add new nuts, and when plenty of smoke is produced the coagulation goes on, but if the smoke is lacking, then coagulation does not take place. I have an objection to make to the name given to the product. He calls it "*Hevea* Para." I think that by Para we understand *Hevea* caoutchouc, and it would be superfluous to say *Hevea* Para, unless it was understood that some of the Para is not from *Hevea*. I think it is not proper to say *Hevea* Para, because we understand it to mean rubber from *Hevea* trees.

Dr. E. Stern: Dr. Pahl asserts that the influence of carbonic acid on latex is the essential feature of the Para method, and that his process must, therefore, produce an equally valuable product with *Hevea* latex. It appears to me, however, that in the Para method one exposes the latex to all the dry distillation products of the palm nuts, and to all those materials which result from the dry distillation of wood. Organic acids, phenols and carbonic acid are collectively the "essential feature" of the Brazilian process. I therefore think that Dr. Pahl's claim is ill-founded.

Mr. Petch: At the exhibition in 1906 we had rubber sent to us from all parts on show. We kept them under observation for three months to determine which was most liable to become mouldy, and the worst rubber of the whole lot at the end of the three months was the hard Para. You will find it on record. So far as we know, at present there is no coagulant which will prevent rubber from moulding.

Mr. Clayton Beadle: If Dr. Pahl has succeeded in a satisfactory manner in coagulating rubber by carbonic acid it appears to be something new in the form in which he introduced it; if so, it is certainly worthy of thorough investigation, but I cannot help feeling that he has been very severe in his arguments against acetic acid. He speaks of acetic acid coagulated rubber being of second quality. I believe that practically

every sample of *Hevea* rubber exhibited at this exhibition is coagulated by means of acetic acid, or rather it contains acetic acid. That is, it has acetic acid imparted to it some time during coagulation. Whether it is purposely added, as is the case in possibly 99 per cent. of the plantations, or whether it is wild rubber (I am speaking of *Hevea* only), it all contains acetic acid, so if he is right in his arguments, what we all at the present time believe to be the best rubber is of second quality. I think we must all agree that his arguments against the use of acetic acid are too drastic and quite unjustifiable.

M. Jayme de Argollo Ferrao: As a Brazilian, when I read the paper I trembled, but very fortunately I saw the next statement, that briefly we had here the only reagent that can give the same quality as Brazilian Para. I should prefer to have him show some samples. As a Brazilian I have a right to consider real Para the first rubber in the world.

Dr. Esch: I am requested by Dr. Pahl to reply for him in English, as he could not follow the remarks. I will first speak of disinfection, and it may be stated that even the finest hard cure Para is not sterile at all. It is not true that all rubber must be sterile. It is possible to get a very fine rubber without any antiseptic. Even in Brazilian Para thorough disinfection does not take place. Then, with regard to the process, the latex is not distilled at all, the nuts are burned in such a way that they produce a large quantity of smoke. You will find if you make a distillation *in vacuo*, that Brazilian Para always contains a small quantity of carbonic acid. I may say, too, that it is quite true that the reaction of Brazilian latex is alkaline. The carbonic acid and other acids that are contained in Brazilian Para give to the Brazilian Para rubber an acid reaction, but the latex is alkaline. Dr. Pahl's statement as to the intimate contact of his carbonic acid with the latex seems to be misunderstood. He makes use of a special spraying apparatus for bringing about intimate contact, and therefore he was quite correct in his statement.

Dr. Stevens: He does not say the latex is alkaline; it is the serum that he says is alkaline.

Dr. Esch: That is in the translation.* It has been stated by Dr. Stern that Dr. Pahl would not be able to get a patent, but that is not so. He gets his patent under the Patent Union.

Dr. Pahl also replied in German.

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* The translation is quite correct. The German in the original MSS. before me reads—

"3. Dass er, resp. das in dem Gummi enthaltene Serum, alkalisch reagiert."

Ed.

Viscosity of Hevea Latex at Various Dilutions.

By Miss A. T. BORROWMAN, Ph.C.

THERE has been of late a tendency to draw a distinction between suspensions of solid particles in a liquid medium and emulsions proper ; that is to say, suspensions of liquid particles in a liquid medium. To the former class belong the well known colloidal solutions of inorganic substances, such as the sulphides of arsenic or of metals such as gold. In the former it is reasonable to assume that the particles are still in a solid condition. To the latter class belong the oil emulsions, and, for less obvious reasons, colloidal solutions of organic origin, such as rubber in organic solvents and aqueous solutions of glue, gelatine, agar, etc.

One of the features which is generally considered to distinguish between the behaviour of individuals of these two classes is the rate of increase of viscosity with increasing concentration of the internal phase. Solutions of the first class (suspensions of solid particles) show an increase in viscosity proportional or nearly proportional to increase of concentration. In the second class (emulsions) the increase in viscosity is much more rapid than increase in concentration.

From this point of view it appeared interesting to make a few determinations of the viscosity of *Hevea* latex. Possibly this has been done before, but I have not come across any published figures. In addition, to the theoretical side of the question the matter has also a practical standpoint. A simple method for determining the rubber content of latex is, I believe, a desideratum on plantations, and it appeared that a rough test for this purpose might be evolved from the results.

The *Hevea* latex used for these experiments had been preserved with ammonia, and had arrived here in perfect condition. One series of determinations was carried out with the latex as received and a second series with a portion of the same latex after dialysis through parchment for ten days.

The viscometer used was of the Ostwald type.

The temperature throughout was maintained at 20° C. and to prevent any risk of blocking the capillary by minute aggregates of globules, the latex was strained through cotton wool. The latter has been found to be safer for this purpose than glass wool, tiny fragments of which are liable to break off and partially block the capillary.

The latex as received contained 29% total solids, and this was used for the first determinations; the same sample, removed from the viscometer, measured, and carefully diluted with distilled water to the required strength, was used for each of the following determinations; that is to say, the same portion of latex was used for the whole series.

The results are shown on the accompanying diagram in the form of a curve.

The figures in the first series of determinations are marked with a cross. It will be seen that up to nearly 10% of solid contents the viscosity is almost proportional to the concentration, but a higher concentration the viscosity increases much more rapidly, so that the curve gradually bends over and at a concentration of 29% slopes at an angle of only about 15° with the horizontal.

It would appear, therefore, that *Hevea* latex in respect to viscosity behaves as an emulsion rather than as a suspension, and that the caoutchouc globules are consequently liquid and not solid.

The figures in the second series of determinations marked with a circle were obtained with dialysed latex and, as will be seen, lie on the same curve as in the first series. The proportion of crystalloidal matters contained in the latex is small, and it is not surprising to find that they do not influence the results beyond the limits of experimental error.

As regards the practical application, a wider range of figures is required and will be obtained before a suitable table can be drawn up.

The CHAIRMAN: We have just listened to a very interesting paper which in the preliminary figures outlined give promise of not only being of great theoretical interest, but of practical service as well. I do not know that I care to make any observations on it myself, but the paper is now open to discussion.

Dr. PETCH: What is the percentage of rubber in the latex?

Miss BORROWMAN: 29%.

Dr. PETCH: Presumably it was diluted.

Miss BORROWMAN: Certainly, it had been preserved with ammonia and diluted to some extent.

Dr. STEVENS: The dilution would be only very slight, but, of course, there was a little ammonia added. Of course, it was dilute ammonia. The total solid in the latex would not exceed 30% or 31%.

Dr. PETCH: Probably it was from a tree tapped daily.

Dr. STEVENS: I should think so; it is very likely. I have in Malaya determined the total solids of rubber in a very large number of latices and from trees tapped under various conditions, but never got higher than, I think, about 43% or 44%. I have never got up to 50% and I have never heard of any latex giving a higher figure than 43% or 44%; 40% seems a pretty high figure. If water is put in you may get any, but I think 30% would be a fair average. I should like to hear what Dr. Petch's opinion is.


Relative Viscosity of Hevea Latex at Various Dilutions at 20°C.
1·5
2
2·5
3
Relative Viscosity, Water at 20°C = 1.

Dr. PETCH : I have not the exact figures ; of course, they are available in other publications. Of course, we tapped old trees. We had groups of 10 trees and they were selected so that the total curve was the same—we equalised everything—and the seven groups were tapped at intervals—one lot every day, one every two days and one every three days up to seven days. We started with a percentage of rubber which did not reach 50%, but varied—I should say about 46%. Of the seven groups, there was one case in which it was only 38%, but that I am inclined to think was a mistake. If you tap every day, your percentage goes down to about 25% and then oscillates between about 25% and 35% for the following year. If you tap every second day your percentage drops possibly to 30% and then oscillates between about 28% and 38%. If you are tapping every week, your percentage drops down to about 40% and then stops at that, so that there is a difference in the latex according to the interval at which you tap. The more frequently you tap the weaker the latex.

Dr. STEVENS : Do you find that the method of tapping affects it ?

Dr. PETCH : I cannot say, but there is a circular which gives you the whole of the figures for the first forty tappings—I believe in every series separately, and, for the more extensive number of tappings, in groups, so that you can cover a year and a half on the percentages of rubber in the latex in different days. In the Straits they have shown the opposite. They have shown a percentage of rubber of about twenty at the first tapping, and increasing to thirty at the eighth, but that is due to the fact that they count the water in the collecting cup as latex and, therefore, the latex is a smaller quantity in the beginning, but the added water makes a difference in the percentage. There is a table published in the Straits which gives the percentage in the latex on daily tappings for about twenty successive tappings, and they show an increase in the percentage of rubber in the latex as the tapping continues. I think we have established the point that, as you go on tapping, you reduce the percentage of rubber in the latex ; you reduce it for about a dozen or twenty tappings and then you get it down to a fairly constant thing, but the standard is lower in daily tappings than in weekly tappings. You will find all the figures in the circular issued in 1910, entitled, " The effect of successive tapping on the percentage of rubber in *Hevea* latex."

Dr. STEVENS : May I ask, do you refer to the Malay experiments ?

Dr. PETCH : Singapore Botanic Gardens.

Dr. STEVENS : My experience confirms the Ceylon work entirely.

Mr. CLAYTON BEADLE : It seems to me that the point upon which the paper bears is the question whether the globules are solid or liquid. In the paper we listened to on the centrifugal coagulation of *Castilloa*, it was stated that the mass contained only 2% of water. If that is so, presumably the globules are anhydrous if you can separate them mechanically and it seems rather that, if they are not liquid by reason of the absorption of water, they may be in a semi-plastic condition in the form of globules ; and their state seems to indicate that, at any rate, at the time they are formed, they are globular and it seems to indicate they are more or less in a liquid condition.

Dr. PETCH : They may be tadpoles.

Mr. Clayton Beadle: They may, if they are in a plastic condition and compelled to alter their shape by passing through channels, or something of the kind, become elongated. I was very much struck with the product yielded by the centrifugal machine described yesterday and which I examined this morning, and also with the product obtained from *Hevea* latex. Taking some of the *Castilloa* product, it breaks to pieces in the fingers just like so much cheese, but if you press it between the finger and thumb it becomes at once an immensely tough mass under the pressure, from a mass which is non-coherent. Some change has immediately taken place as the result of the least pressure applied to it.

Dr. Stevens: I might perhaps add that that is really confirmatory of what was said many years ago by Weber, who said that if you put coagulated rubber between the rollers of a washing machine you get this toughening effect.

Some Remarks on the Preservation of Rubber and on the Preparation of Plantation Rubber.

By Dr. WERNER ESCH,

The Para rubber of the Amazon valley, in spite of its uncertain botanical origin, represents to-day the most reliable raw material known in the rubber industry. It has been stated by several botanical authorities that Amazon Parà rubber is not only derived from several species of *Hevea*, but that other rubber yielding latices are used to adulterate *Hevea* latex.

In the case of plantation *Hevea* rubber, one has, of course, a guarantee of a definite botanical origin, but the cases, when plantation rubber from Ceylon arrived in Europe in a sticky condition, are too fresh in our memory for us to have unlimited confidence in rubber of uniform botanical origin.

However different the various latices used in the production of Parà rubber may be, they are all worked into Parà rubber by the so-called smoking process. The collected latex is uniformily worked into *borracha fina* in the following manner :

It is poured into flat pans, then ladled on to a wooden stick, which is mounted like a spit, the middle of which is sometimes thickened by a lump of clay ; that part of the stick, which has been moistened with latex, is then exposed to the smoke of a fire, while the stick is kept turning. The oily nuts of the Urukuri palm are used for producing a smoky fire. Very special effects were traditionally attributed to this nut-fire smoke. The heat of the smoke and the chemical compounds contained in the smoke cause the formation of a thin layer of rubber on that part of the stick which is moistened with latex, and on this layer more latex is poured, while the stick is constantly turned. The stronger the smoke to which the latex has been exposed, the more distinctly can the layers of rubber skin obtained by this process afterwards be seen and separated. If the smoke is only mild, the latex does not coagulate so perfectly, and adheres more intensely to the latex, which is put on afterwards with the skin formed therefrom, the consequence being that with so-called soft cure Parà rubber the single layers of rubber can only with difficulty be torn off skin by skin, as is in the case of hard cure fine Parà rubber.

In several books on rubber the authors speak of dry destillation of the nuts and the strong antiseptic power of the products of such a dry distillation. It is probably incorrect to speak of dry distillation in this case. The Urukuri palm-nuts burn well, but they contain enough water, oils, etc., to make them produce a heavy wet smoke. This smoke contains, of course, the same products of the burning process as any other smoke of green wood or the like, but it is not incomplete combustion accompanied by the production of lamp-black, and therefore this smoke does not contain carbon monoxide, which could only be produced by a reduction of carbon dioxide by means of high-heated carbon. Carbon monoxide should, therefore, be left out of consideration.

I maintain, farther, that we cannot correctly say that even Amazonian Parà rubber is really sterilized; nor is this necessary for the production of good rubber, as is easily perceived in the case of Matto-Grosso virgin rubber, caucho balls, etc.

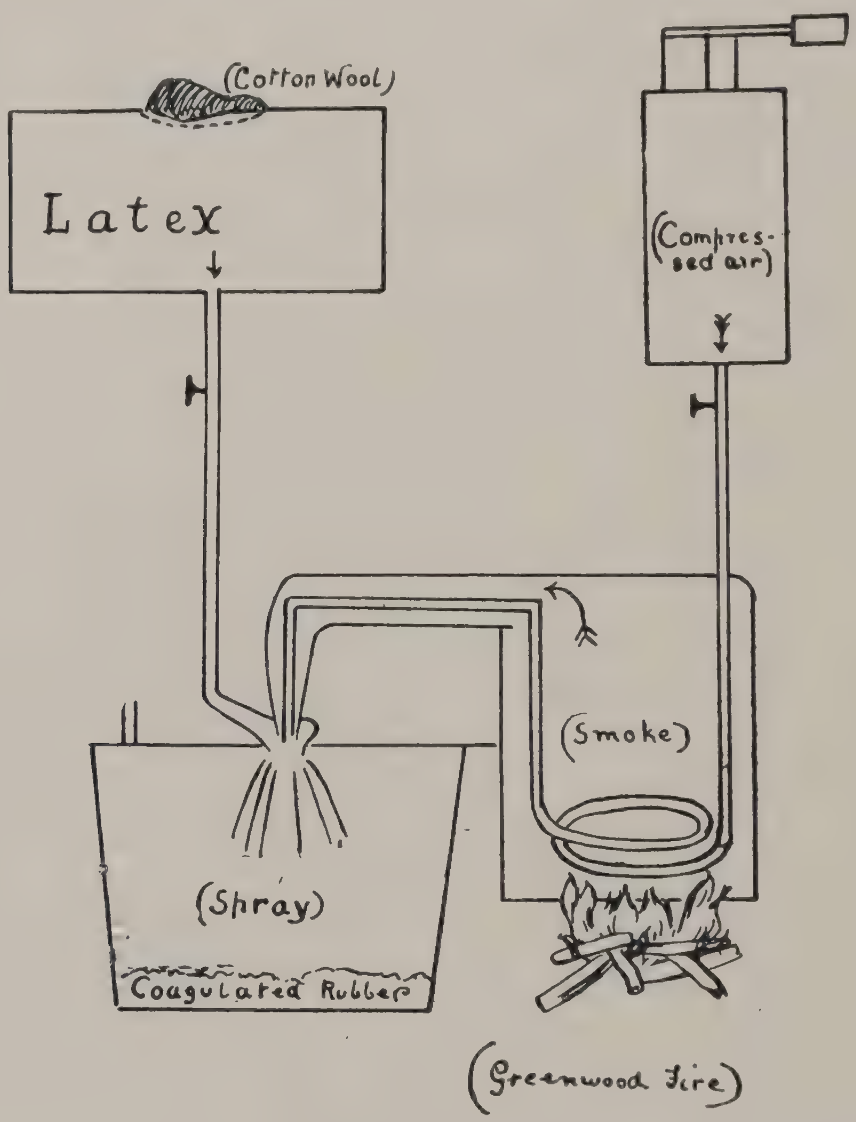
It is true that the smoking process does have a preserving influence. The "proto-rubber" globules of *Hevea* latex become coagulated in the form of extremely thin skins on the ball by the heat and the contractive ingredients of the smoke, but these thin skins remain wet and hold dissolved in their moisture nearly all the coagulating ingredients of the smoke. Each particle of rubber remains in an intimate contact with the quite harmless coagulating ingredients of the smoke. The ingredients are: carbonic acid, formic acid, acetic acid, and phenol-like substances. In the ordinary washing and drying processes executed in rubber factories, all these smoke-products are removed—except a portion of the phenols. I agree with Messrs. Clayton Beadle and Dr. Henry P. Stevens that unwashed Amazonian Parà rubber contains a very distinct trace of acid, but I maintain that after careful washing and drying such rubber is totally free from acid.

The fact that these quite harmless coagulating ingredients remain within the wet Parà rubber secures an extraordinarily and thoroughly polymerised rubber. Freshly shipped Parà rubbers are not as good as long-stored Parà rubbers of the same kind. The higher value of Bolivian Parà rubber is due to the fact that Bolivian Parà rubber travels a far greater distance before reaching our wharfs, and gets better "ripened" through the action of the coagulating ingredients dissolved in its moisture. It seems to be impossible that there should remain any traces of "proto-rubber."

I maintain, further, that in the preparation of Parà rubber by the Amazonian smoking process, especially in that form, which is usual in the Bolivian rubber districts, a certain separation of the latex into two portions takes place. One portion of the latex—and especially the higher polymerised part of the latex—is rapidly coagulated by the smoke, and adheres to the above-described stick in form of a thin skin of rubber, but the serum, together with lower-valued parts of the latex, drips down. The smoked rubber balls contract themselves, because the rubber becomes stronger and more tenacious by and by, and this contraction causes the serum of the rubber to be pressed out. If this separation of the latex remains imperfect, only soft rubber results, while hard rubbers are obtained if the seringuero handles his latex in such a manner that a part of the latex drips down from the stick.

I propose the following process:

Hevea latex should be gathered by the usual methods and filtered in the factory. Then the latex should be handled by means of a spray, as illustrated by the following sketch.



Compressed air or another gas may be used for the purpose of producing a suction of smoke from green wood, and in the same time a suction of the latex. A spray distributes in a kind of fog the smoke and the latex, and thus brings them into close contact. The wet mass of coagulated rubber may then be centrifugalized by a Michie-Golledge machine.

We should then be ready to crepe the wet rubber, but I prefer to press it into blocks. Such blocks furnish a product much nearer to hard cure fine Parà rubber than any obtained by creping.

The ingredients I suggest—compressed air and smoke of green wood—must be considered as quite harmless and very cheap.

For use with *Hevea* or *Castilloa* rubber, the latex could be handled by the described method without any other addition than water, or without any addition, but I think it to be necessary, for example, to make *Funtumia* latex alkaline by means of quick-lime before handling it as described before.

I hope this idea may be found worthy of consideration.

Dr. PETCH: Do you find the same amount of protëin and ash in biscuits made by the acetic acid process as you do in the hard Parà?

Dr. ESCH: It may be, if you make use of the centrifugal machine.

Dr. PETCH: The Henry Goddard analyses are of biscuits made in a pan in the olden fashion and the ash and protëin are practically the same. That is the ash under 1 per cent. and protëin between 2 and 3.

Dr. ESCH: I think these biscuits must have been made by "creaming up" the latex.

Dr. PETCH: They were made by the usual acetic acid method.

Dr. ESCH: But you cream it up. In Ceylon and the Malay States they do not gather the rubber in such a way that the mineral water is kept back in the rubber.

The CHAIRMAN: It can hardly be called a creaming process. The coagulation is like what you see in the kinematograph, and involves rapid agitation.

Dr. ESCH: If you add acids to the latex the rubber creams up and in the liquor you get back nearly all the mineral matter. You have only a small amount of mineral matter in the rubber.

Dr. PETCH: How do we get the same analysis as in hard Parà ball?

Dr. ESCH: I should think you would get the same analyses if you make use of the same coagulating ingredients. That is to say, if you use only smoke.

Dr. PETCH: No, no; when we use acetic acid and cream it up we get the same analyses. I think you will find, if you compare them, that we get the same analyses as the hard Parà ball.

Dr. ESCH: It may be so in the case of resin and protëin, but you do not get a rubber which has the smell, and which contains the product which has the odour of bacon. It seems to be nearly the same, but it cannot be that the products are the same. The quantity of products you get may be the same as in Parà, but it must be taken into consideration that there would be a difference in the protëin when acetic acid is used.

Mr. WHALLEY: Is your chief point that the coagulating agents are locked up in the Parà rubber balls up to the time they are used in the factory, that is, that it may be for three months they are locked up in the balls? In the best plantation rubbers they should wash out almost immediately.

Dr. ESCH: But you cannot get rid of some of these products unless you wash the rubbers in the same manner as you wash them in the factory. I propose that the planters should not produce quite a dry product by this method, but they should produce a product which is nearly of the same dryness as Amazon Parà rubber. I intended to say that the Amazon rubber owes its good quality partly to the separation of part of the mineral matters and protëin, by the dropping back of part of the serum as described, and partly to its being kept in quite close contact with the coagulating agents which are taken up by the rubber in the smoking process; and I wish to state that these ingredients —carbonic acid, formic acid, acetic acid, and other matters—have a low concentration only. At these low concentrations these acids are quite harmless, and the rubber which is kept in intimate contact

with these ingredients must be transformed completely into real rubber; the "proto-rubber" of the latex must also change into real rubber. I published a paper with Dr. Wallace some years ago in which I stated, as the result of experiment, that there exists only an oily substance in the latex, and that real rubber does not exist in the latex; it is only an oily substance, and this becomes rubber by means of coagulation, Statements made by Prof. Hinrichsen do not contradict this statement. because he only states that this oil is a definite compound.

Mr. FOL: I think this problem of the existence of the oily substance is not solved.

Dr. ESCH: It is solved. I beg to refer you to my paper. If you had the same rubber in the latex as you have afterwards in the coagulated mass you could not get it into solution by simply stirring it. In the latex, on the other hand, you have an intimate contact of water and the oily substance, and you will be astonished to see this oily substance go in a moment into solution if you shake it in a flask or stir it.

Mr. FOL: The surface tension may go down very much.

Dr. ESCH: If you take *Hevea*, or any other latex, you will find that the viscosity increases greatly simply by standing in a dark room.

Mr. CLAYTON BEADLE: I understand you get about ½ lb. back into the pan out of every 10 lbs. of latex.

Dr. ESCH: That is only an estimation. If you take 10 lbs. of *Hevea* latex and you proceed with the smoking process you do not get a large residue of uncoagulated latex in the pan, because the greater part of the water goes away by evaporation. The important point is that the residue which remains in the pan contains a larger portion of mineral matter, and a larger proportion of protëin.

Dr. HUBER: Why?

Dr. ESCH: It does. We have stated it, and I have stated that in the smoked ball you do not have as much mineral matter and as much protein as would be found if only evaporation of the water from the latex takes place.

Dr. HUBER: I think that the separation which Dr. Esch has found is apparent not during the smoking, but afterwards when the ball is giving out a sort of serum, and, of course, this serum which is excreted by the ball contains soluble matters, but this excretion is only separated after the smoking in a separate room where the balls are kept for some days after smoking, and the scrap which is taken from the pans is not mixed with this liquid which drops from the balls.

Dr. ESCH: The smoking process is not a quick one, and a slight separation takes place in the pan. The rubber collects more or less toward the surface, and if you take up from the surface of the pan some latex it will not be like what you would get if you stirred the latex and took a sample directly after tapping. You will find, too, at the bottom of the pan, substances which look quite like those that are separated from common milk. If you heat milk you will find at the bottom of the pan crystalline matter. I may say further, that I got examples used in my experiments from a cousin of mine who is the owner of seventeen steamers on the upper Amazon.

Dr. HUBER: I do not deny that to a certain extent that may be the case, *i.e.*, that there may be a separation in the pan in which the

latex is poured after collecting, and whence it is taken for smoking; but generally I think that on taking out some of the latex in a small bowl without any special care, the liquor is stirred up.

Dr. ESCH: I have been told by those who have been to the Amazon that in the lower grades of smoked Parà the serum has no opportunity to get away in the smoking process. If the serum, which contains a large proportion of mineral matter and protein, is enclosed in the rubber, then we classify the rubber as a lower grade of rubber. In this condition the rubber will have much more moisture than common Parà rubber. You will find that sufficiently cured hard cure fine Parà comes on the Hamburg market with a shrinkage only of 14 per cent. or 15 per cent. If it has more than 15 per cent. of moisture you will find that the amount of ash and protein will be higher, and I say this upholds my view.

Dr. HUBER: In the production of "entrefine," instead of simply pouring latex over the ball there is sometimes added a small amount of strips of already coagulated rubber. These strips, of course, have not been smoked in the proper way, because the smoke does not penetrate as it would with a thin layer of latex, and these parts contain more moisture than the thin layer which has been exposed to the smoke.

Dr. ESCH: You will find examples of entrefine rubber which are quite slimy in the interior; it is impossible that this may be caused by introducing strips.

Dr. HUBER: It is not strips but cakes.

Dr. ESCH: Self-coagulated portions of the latex, but this slimy material you will find in some kinds of entrefine rubber, so that there has taken place an evaporation of moisture. The moisture has had the tendency to evaporate, but the exterior layers of the rubbers round the ball prevented the serum from flowing down, and therefore you get this special light grade of entrefine.

Dr. HUBER: I think that my principal difference of opinion from Dr. Esch is that Dr. Esch thinks that before the smoking, and in the act of smoking, there is already a separation of serum. My opinion is —perhaps I am not right—that the separation of this sort is apparent after the smoking, and when the ball begins to perspire and separate. After the smoking liquid drips from the ball, then the ball is covered with new layers which also drip.

Dr. ESCH: Do you mean that there takes place a contraction and then the liquid is pressed out?

The CHAIRMAN: It is a very important point.

Dr. ESCH: I do not consider it of great importance whether the separation of the serum takes place during smoking or afterwards. I thank you for the patience with which you have listened to me, and I must now go away as I have an appointment.

The CHAIRMAN: This is the only sitting of the Conference devoted to historical and general subjects. There was one paper on the list, but the author does not appear to be here. I will invite a general discussion on any points of interest.

Dr. HUBER: I should like to know the opinion of manufacturers about the inferior grades of Parà—unsmoked Parà from the wild rubber estates—because it is very interesting to know what the opinion of manufacturers is on unsmoked Parà from wild rubber.

The CHAIRMAN: I think I can give a partial answer to that question. It has not been an uncommon thing at all to get occasional lots of third grade rubber—what used to be called *sernamby*—which the manufacturer would rate nearly as high as the best Parà and which he could use for many of the same purposes. I am not saying it would be always the same, in fact it was very variable, sometimes it was extremely good and sometimes extremely bad, but I have seen so many good lines of it that I should be inclined to regard it as established that sometimes rubber that has not been smoked by the regular method may be as good as what has been so smoked.

Mr. WHALLEY: You compare smoked Brazilian Parà with unsmoked, but do not compare unsmoked Brazilian Parà with plantation Parà.

The CHAIRMAN: That is a different question.

Dr. HUBER: I should like to have a comparison between unsmoked Parà and plantation.

The CHAIRMAN: What I said before would partly answer the question, because it amount to stating that some lots of *unsmoked* Brazilian Parà are as good as anything ever made in the way of rubber.

Mr. KELWAY BAMBER: In clots or in scrap?

The CHAIRMAN: I cannot answer that from memory.

Dr. HUBER: There are two kinds of scrap rubber exported from Parà—the real scrap from the trees and from pans, and a sort which is coagulated on the trees.

The CHAIRMAN: On the trees?

Dr. HUBER: Yes, in the tins on the trees. These two are differently paid for. This latter kind brings a better price than the real scrap. Of course, there is some that is dirty or prepared from mixed latices, and these would be found inferior to plantation and to other *Hevea* rubber, but the best of this scrap is superior to plantation Parà prepared in the usual manner. It seems that the values of the different kinds of Brazil Parà and plantation Parà are not wholly fixed by the mode of preparation, but also by the constituents of the latex. The unsmoked after being washed may be equal to the smoked. The smoking process mainly insures better preservation. The rubber is the same whether prepared by smoking or by proper drying. I think that rubber dried on the tree has sometimes the same elasticity and is quite as good as the smoked Parà. The difference in the price is explained by the fact that the scrap is dirty and is not so well prepared.

Dr. ESCH: I was manager of a large rubber works in Hamburg for several years and am now in close connection with several of the large rubber works in Germany, and can say that there is a large difference in the quality of the highest grade of *sernamby* as compared with Parà or with plantation rubber. Even the best grades of *sernamby* are not able to give English cut sheet or rubber goods of high quality. The elasticity after being masticated is very low in comparison with the smoked Paràs. I stated yesterday, or the day before, that most of the plantation rubber now on the market are unable to stand much mastication, and all large manufacturers who use hard cure rubber will agree that you cannot use plantation rubbers for rubber goods that have to stand attrition, such as motor tyres. Even cold cure goods made from some kinds of plantation rubber, although they look very beautiful for a few months,

cannot be kept in the shop for several years. On the other hand, there are some large works in Russia and Germany that give a five years' guarantee for their rubber goods in storage. These people cannot make any use of plantation rubber, but they can use *sernamby*.

Dr. HUBER : Then you think *sernamby* of better value than plantation ?

Dr. ESCH : For some purposes plantation rubber is of more value, and in some cases *sernamby* of better value. I remember we made an addition of *sernamby* in some cases where the hard cure fine Parà is too refractory under mastication. You do not get an intimate mixing of the components if the rubber is too hard, so they make an addition of *sernamby* and then they get an easily worked mixing with hard cure fine Parà.

Mr. WICKHAM : With regard to the quality of the latex east and west, I can assure Dr. Huber that the question is entirely one of cure. In the East at present they are not making the smoke cure, and to illustrate what I mean I have left some samples with the Chairman. I dare say he will confirm what I say and illustrate it better than I can. The latex was worked up at the time of the former exhibition. I obtained about one pint of latex from Mr. Bamber and made it up on the Parà system of hard cure. At the same time I obtained from the Chief Commissioner of the Amazon a specimen of the hard cure rubber from the Madeira plateau. When I left England I put them away in a box that they should undergo the same hardening process under the same conditions and for the same period of time ; and this is the result (holding up specimens). This is my sample, and this the Parà. I think it will be seen what the character is.

The CHAIRMAN : I should like to remark with reference to one statement of Dr. Esch, that large quantities of plantation rubber are used in motor tyres. I think the question of using plantation rubber in almost any kind of goods is not a matter of touch and go, not a matter of a single experiment that does not happen to turn out well, but is a matter of steady and determined effort. Another thing Dr. Esch emphasises with a certain degree of justice is that a good many plantation rubbers do not stand milling quite so well as fine Parà, but we must temper that a bit by recalling, what all must know who have handled rubber, and what Dr. Esch must know, that it is not an uncommon experience to see two specimens of rubber one of which masticates beautifully on the mill, stands breaking down, as they say, very well indeed ; and another one that breaks down much more readily and that does not seem to stand milling as well ; and yet when the two are vulcanized one is as good as the other. It is not true that you can tell by the behaviour of rubber on the mill how it is going to behave when vulcanized.

Dr. ESCH : I may say there is some difficulty in getting enough plantation rubber of the same kind. I said the day before yesterday that the chairman of a large rubber works said they have a difficulty in getting English cut sheet from plantation rubber, and that is one of the most important tests that can be made. If a rubber will give a good quality of English cut sheet, then it is a very fine quality of rubber, and there are some kinds of plantation rubber which can be used in the preparation of English cut sheet. But most of the manufacturers of rubber goods fear that there will not be a satisfactory supply of such

kinds of plantation rubber for that purpose, rubber that they can purchase by 10 tons and more to-day and then get 10 tons again later. There does not to-day exist a plantation able to put on the market 10 tons of uniform rubber. Perhaps this point is of more importance from the standpoint of the manufacturers. They do not want to declassify plantation rubber—not at all—they would be very glad to have the quality of plantation rubber increased, so that it would be a reliable kind of rubber for their mixing. At present they are unable to make a large use of this rubber for such things as tyres. For making tyres we use in Germany mixings which weigh nearly 300 kilogrammes, and we use mixing rollers of great size: you cannot get uniform rubber enough from any plantation or plantations to use at such a rate.

The CHAIRMAN: That depends a great deal on the methods of the factory. The word "cannot" is a word that always has to be weighed a bit before you can take it at its full face value. The "cannot" of a factory very often means simply that perhaps they could do it but do not care to take the time or trouble. For instance, the difficulty Dr. Esch has mentioned about non-uniformity. Manufacturers have, in past years, got along with rubber of very varying quality. It is perfectly true that while we are demanding uniform plantation rubber to-day, in past years the manufacturer has constantly used grades that were not by any means uniform. He has got along by cutting according to his cloth. To say a thing is not done, is one thing; to say it cannot be done, is another thing altogether—that should never be said until every process known has been tried and found to fail absolutely.

Mr. F. CROSBIE ROLES: You have voiced a line of thought to which I was going to give expression. I may say that we in Ceylon found the same difficulty in the early days. We had the crime of being young, and we found merchants and manufacturers with their settled business methods doing very well and seeing no reason why they should go out of their way to create a market for a new product. Of course, we are getting over that objection, and I feel that manufacturers who will help with experiments will help us to arrive at standards. The result of this Conference will no doubt help in the production of equal standards of produce.

Dr. HUBER: With regard to the superiority of wild Parà rubber, I think we may take it from the discussions at this Conference that the superiority of the wild Parà is only in the method of preparation and that that accounts also for its uniformity. That seems to be the opinion of chemists and manufacturers, that the superiority of wild Parà is not in the composition of the latex but in the manner of preparation.

Mr. CHRISTISSON: Is it not a matter of regular coagulation? Do they not all use the same stuff for coagulation in the East?

The CHAIRMAN: I am not clear in my own mind about that.

Mr. CHRISTISSON: What are they using in the plantations?

The CHAIRMAN: Mostly acetic acid. The statement has been made here a number of times that probably nine-tenths of all the rubber in the East is coagulated by acetic acid.

Mr. SUTER: There seems to be a great elasticity of opinion as to whether hard Parà is superior to plantation rubber. I think it is on account of the youth of most of the plantations; there is an insufficient

quantity coming over from particular estates, and that is a difficulty which the Chairman has disposed of. By a good knowledge of planting the trouble can be overcome. As regards the manufacturers, there are a good many grades of rubber coming into the market: one buys one, and another prefers another. Some seem to think it a matter of fashion, like ladies' hats—one day one thing and the next day another. The manufacturer has never seen fit to give any reasons why he changes his methods, or if he has done so it was not in a sufficiently clear form to give the planter the information he wants. I have no doubt the planter is willing to meet the manufacturer's views if he only knew what was wanted, but as there is no information on that point he pleases himself entirely and is perfectly justified in doing so. He follows a method suited to his own convenience, and to secure uniformity there would have to be some co-operation between the planter, the scientist, and the manufacturer. The three must work together. Of course, it is the same with all new industries, and will right itself in time. There is no doubt that with a freer exchange of opinion, and closer contact of the different interests, and a greater readiness to adopt new methods, the difficulty will be at an end.

The CHAIRMAN: This point continually comes up about the manufacturers giving information to the planters as to what is wrong with the rubber. Now, I speak with all modesty in this matter, because on neither side do I know as much about it as a good many others; but it appears to me, as one who has had more or less experience in a problem not altogether unlike the one we are speaking of now, that if this method were followed you would be simply involving yourselves in trouble. I had a long talk the other day with a gentleman connected with one of the largest manufacturing establishments in Britain, and he said to me, "What is the use of bothering about the composition? I do not care what the composition is; I do not care whether it is 10 per cent. or 5 per cent. of resin or protëin; what I want is to be sure that what I buy once I can buy again—that is all we want. We do not want to go into questions of detail. The chemists will attend to these, and when they get their results they will tell us. The point is that all these years we have been taking anything that came along, and we can use anything that is coming along now, provided some way can be devised by which we can have reasonable assurance that when we buy a thing once we can go into the market and buy it again." In my opinion that presents the whole problem in the simplest form. Take the case of large creameries: they manage to produce a uniform article, yet they produce it from milk brought in from all parts of the country. They turn out a product that must be recognised as a practically uniform market product. How do they do it? They do it by the various milks being sent to one creamery. The treatment of the milk corresponds to coagulation. It is churned and the butter made, and it is put upon the market and recognised to be of a good degree of uniformity. A similar process of dealing with latex, it is reasonable to suppose, would produce a uniform quality of rubber. Planters can take a leaf out of the book of the butter makers, and it would be a vastly more simple way.

Dr. PETCH: There are two points I have noticed in the discussions, of complaints against plantation rubber. One is that it is not as good as it used to be, and the other that you cannot get it uniform at the present time. With regard to the first, the explanation of the botanists is fairly obvious: that plantation rubber first began to boom about

1904 and that the trees now being tapped are very young. We have had a statement in the East that the age of the trees makes no difference whatever to the quality of the rubber, but we have never had figures. We have had statements that when two samples of rubber taken at the same time are coagulated the same way—it does not matter what coagulation is used—the sample from the older tree is always reported better than from the younger tree. I can refer to two samples from Singapore: one from trees 25 years old and the other from trees eight years old. In the older trees the rubber was said to be equal to hard Parà, while that from the younger trees was 8 per cent. worse than hard Parà. In Ceylon we have two sets of specimens with the same result, almost exactly, as in the report on the rubber from the trees of the same ages in Singapore, showing that the rubber from the older trees is the best. I do not see any escape from the conclusion that the rubber from young trees is weaker than from older trees. We can therefore understand why the rubber coming in at present is not uniform, and why it is not equal. The bulk is from recent plantations. The Chairman has suggested that we should bulk the latex. We were always told not to do that, because we should only get the price of the worst. We have always been obliged to keep the latex separate and have two or three grades according to the age of the trees, but if it is thought that bulking the latex will give a uniform quality we shall be only too glad to save labour by bulking.

Dr. Black: I made a lot of investigations on this, and agree with the last speaker as to the cause of the complaint of want of uniformity. Unfortunately, in matters connected with rubber the curse of everything that is published is that people will persist in making two or three small experiments and generalising from them. That, unfortunately, has led to most of the fallacies that have been printed and published. It is like that idiotic contention about close planting. So it is with this question of the rubber from young and old trees. In Brazil I took latex from trees the age of which it was impossible to ascertain and from young trees in plantations, and made extensive tests over many months, and satisfied myself absolutely that the latex of the young trees was inferior.

The Chairman: Vulcanization experiments?

Dr. Black: I also made vulcanization experiments and under all tests found the latex from young trees not equal to that from old. I do not, however, agree with Dr. Petch on the question of mixing. It is very much like whiskey. If you go to a shop and buy a whiskey said to be 10 years old, some of it may be, but not more than 5 or 10 per cent. of the total, and a lot of it is only 12 months old; and so it will be with the rubber.

Mr. Whalley: Do you not think there is some misunderstanding often owing to the different meanings attached to the word "uniform"? Uniform, to the planter, means the uniformity of the product of his estate. I had an instance recently when visiting a crude washing company. They had an exhibit of all kinds of rubber, washed and semi-washed, and I said "Do you guarantee uniformity?" And he said, "We guarantee uniform quality of the washed rubbers." I said, "What do you mean by uniformity?" They replied, "That you shall not get more than a 10 per cent. loss in washing." I said, "You are not interested in quality, only in loss in washing." There are 5,000 manufacturers, and it is impossible to get them together to give a

standard definition. A manufacturer goes on the market and buys rubber, say 5 or 10 tons ; in another month he wants another quantity, and from no individual can he get the same quality. That is the source of the trouble. He has to get mixed lots to make up his 10 tons.

Mr. F. Crosbie Roles : Did I understand Dr. Petch to say the age of the trees had nothing to do with the results ?

Dr. Petch : I alluded to the fact that we had been told that the age of the trees had no effect on the results, but no figures have been published, and we can only put the statement aside.

Mr. Crosbie Roles : It was a distinct and definite statement made on behalf of a company, but, as Dr. Petch has said, we can get no further information because they will not disclose details. It was published as coming direct from the company. The company sent a letter to Ceylon, and I discussed it with the company's representative, Mr. Edgar B. Davis, and he assured me that several chemists worked on it and quite satisfied themselves. I said I did not think he would convince the general public and that more experiments must be made.

Dr. Petch : It depends on the ages of his trees. Perhaps they only treated trees varying from 8 to 10 years old, the tests being made in Ceylon. He would not get rubber in Ceylon with a greater variety of ages, but he could from Singaproe.

The Chairman : What are the oldest trees in Singapore ?

Dr. Petch : Thirty-three or 34 years old.

Mr. Wickham : There are half-a-dozen of the original stock which went to Singapore.

Dr. Petch : That would be in 1876.

Mr. Wickham : The bulk of the 70,000 were scattered in India, Burma, and other places.

Mr. Suter : Referring to the remarks with regard to uniformity, I think something might be achieved by the influence of the visiting agent. The visiting agent ought to be able to arrange a fairly high standard of uniformity by advising the companies. I take it that it is the visiting agent who advises the managers. There seems a possibility of getting uniformity in this way.

The Chairman : I think we have now reached the limit of the discussion, and the Conference will adjourn.

The Viscosity of Rubber and its Solutions.

By PHILIP SCHIDROWITZ, Ph.D., F.C.S., and
A. H. GOLDSBROUGH, A.I.C., F.C.S.

In a previous paper[1] the general characteristics of rubber solutions with respect to viscosity, and a method for determining the viscosity of rubber solutions were described. A method for calculating the viscosity of the material as such from the *data* obtained by work on solutions was suggested, and some facts regarding the bearing of the viscosity of rubber solutions on the strength or "nerve" of rubber were set forth. The work on viscosity has been continued, and while much remains to be done, we think it may now be of interest to briefly state the general nature of the results obtained.

Effect of Heating (in solution) on Viscosity.

General theoretical considerations might lead one to expect that the effect of heat on a rubber solution would be to decrease the viscosity of the solute[2], but on testing this theory experimentally it was found that it by no means held good in all cases. Thus a sample of rubber from a 30-year-old (Ceylon) *Hevea* after heating in (benzene) solution for two hours on the water bath increased in viscosity from 9,500[3] to 13,200, and similarly a sample of *F. elastica* from an old forest tree showed an increase from 16,600 to 17,200. On the other hand, a series of plantation rubbers showed material decreases, as will be gathered from the following particulars:

Plantation Hevea: Effect of Heating in Solution.

Description.	Notes on Solutions.	Viscosity.	Viscosity after heating 2 hours on a Water Bath.
From old trees (block)	Practically no insoluble matter. Light colour.	10,000	7,450
From old trees (thick crepe)	Ditto, light colour	7,700	4,968
From young trees (thin crepe)	Ditto, slightly brownish yellow	4,400	3,179
From young trees (biscuit)	A good deal of insoluble matter. Light colour	8,800	4,273

A rather poor and old sample of "soft cure" Para, submitted to the same treatment as the above specimens showed an increase from 9,000 to 9,340.

(1) *Schidrowitz and Goldsbrough.* "Journal of the Society of Chemical Industry," 1909, page 3.

(2) The viscosity determinations were made in every case at the standard temperature of 20°.

(3) These conventional values are obtained by drawing a tangent to the viscosity curve at a concentration of 1 per cent., calculating its value on a standard scale (1 cm. = 2 viscosity units and 0·1 per cent. concentration) and multiplying the result by 1,000.

These results are of considerable interest, and appear to indicate that, according to the state of aggregation of the rubber substance, heating in solutions may have either a dis-aggregating or the reverse effect.

Effect of Deresination.

In the case of *Funtumia elastica* it was found, as might have been expected, that the general effect of resin extraction (by acetone) was to increase the viscosity. A somewhat immature plantation *Hevea* sample showed a decrease. The following figures were obtained :

Effect of Deresination on Viscosity.

No.	Species.	Viscosity Direct.	Viscosity after Deresinification.
1.	*Funtumia Elastica*	14,913	20,588
2.	,,	14,415	17,702
3.	,,	15,709	17,896
4.	,,	15,211	15,521
5.	,,	9,045	11,136
6.	,,	15,300	14,524
7.	,,	9,045	9,347
	Plantation smoked	7,552	4,990

With regard to the samples in the above table, Nos. 1, 2 and 5 contained a high, Nos. 3 and 7 a medium, and Nos. 4 and 6 a low percentage of resin. It is interesting to note that the samples which showed only a slight increase (4 and 7), and No. 6, which showed a slight decrease, all contained considerably more nitrogen than the remaining specimens. It will be observed that the only sample which showed a material decrease was the plantation *Hevea*.

Effect of Method of Coagulation.

Three different methods were applied to the same batch of *F. Elastica* latex. The viscosity figures obtained were for Method A 17,000, Method B 17,400, Method C 12,800. In another series of *F. Elastica* experiments we found that rubbers obtained by 10 different methods gave figures varying between 11,400 and 18,000. As far as plantation rubbers are concerned, we have observed a very wide variation, results ranging from 2,500 to 15,000 having been obtained. While some of our figures refer to specimens in regard to which the question is complicated by differences of locality and age, it is clear, comparing rubbers obtained from trees of practically the same age from one district, that the method of coagulation and preparation generally has an important influence on the viscosity of the product.

Practical Value of Viscosity Determinations.

During the past three years we have examined a very large number of crude rubbers by the viscosity method. In a number of instances we have been able to compare the viscosity figures with results obtained by examining the vulcanized products obtained from such specimens. While we reserve details for a subsequent communication, we may state that, as a result of our experience hitherto, we are satisfied that within the *same species* viscosity measurements give a direct line as to strength, general condition and vulcanizing capacity. Where numerous samples have to be compared rapidly, either with one another or with a standard article in regard to strength and behaviour towards vulcanization, the estimation of viscosity is of extreme and practical value.

The CHAIRMAN: The paper is now open for discussion.

A question was asked as to the percentage of rubber used in the solutions.

Dr. SCHIDROWITZ: We generally work on solutions from 1% down to 0·25%. In every case the strength is exactly determined on the solution itself by evaporation. That is to say, we do not take anything for granted as to the strength.

The CHAIRMAN: In the forms of apparatus you have described so far, do you consider that you have described the simplest possible form that could be used, and the simplest manipulation that would give fairly accurate rseults.

Dr. SCHIDROWITZ: The only trouble about viscosity determination is that apparenlty you cannot get a direct result by one reading only, on account of the nature of the curve. I think, however, if one was dealing with one type of rubber, say the output of a particular plantation, one might get a fairly reliable result by taking one reading at 1%, but it would not be as accurate.

The CHAIRMAN: Still by continued observation on the plantation, a man following it up for months right along might get to a point where it might turn out to be of value to him.

Dr. SCHIDROWITZ: I think so decidedly. The great point about preparing the solution is that it has got to be quite bright. You must not have any matter that will stick in the viscometer, because the bore is a milimetre or less, and when I have had a very high result I have had it repeated and found that somehow or other a little bit of insoluble matter had got into the viscometer. It occurs very rarely indeed. The method is to cut up the rubber in small pieces and place them in a high cylinder, cover with benzine, and incline the cylinder, so that we get a big surface, and every now and then give it a shake. Then you let it stand and the insoluble matter comes down, and you can pour off and have a practically bright solution to start with before filtering. I may say we use that method for determining insoluble matter. I do not think it has been published yet; it is so simple that it is curious it has not been published. You have no errors due to filtration and with regard to the method indicated by Spence of weighing the residue, I must say I do not like it at all, because the least little bit of rubber remaining on the filter throws the whole result out, and it is very difficult to wash out the rubber.

A question was asked as to how viscosity depended on the heating, and what was the effect of handling.

Dr. SCHIDROWITZ: The viscosity depends very largely indeed on temperature—it is generally known that it depends more on temperature than on any other factor and that applies to rubber as well as to other viscosity determination. We are very careful to get the temperature within the limits of 0·1 to 0·2 degrees. I believe a difference of one degree will give you a very appreciable difference in the viscosity figure. I should not like to give the figure off hand, but we have made tests from 10 degrees downwards to 30 degrees upwards.

Dr. W. OSTWALD: I agree that temperature is a great factor, so that it would be safe in all cases not to give figures but always to give curves.

Dr. SCHIDROWITZ: All these figures are based on curves. About the handling of rubber, that has a great effect indeed on viscosity. For instance, I took a Para specimen which showed a viscosity of somewhere about 12,000, and I manipulated it on the mixing roll until it was absolutely "killed" (in the commercial sense) and the viscosity went down to about 500. It was absolutely enormous the difference that took place Then if you let rubber stand, of course it goes back a bit. That is well known to manufacturers.

Mr. KELWAY BAMBER: Does drying the rubber beforehand affect the viscosity?

Dr. SCHIDROWITZ: What we do in that case is to dry in a vacuum.

Dr. WERNER ESCH: Did I understand you to say that a solution standing some days in a dark room loses viscosity?

Dr. SCHIDROWITZ: I have not made any statement regarding that, but, as a matter of fact, I have observed in some cases that the viscosity does decrease.

Dr. ESCH: From standing in dark rooms.

Dr. SCHIDROWITZ: Protected from light anyhow; we always protect from light. I found after a period of six weeks the viscosity goes down very appreciably in some cases and in other cases practically not at all, or very slightly.

Dr. OSTWALD: I have found cases in which viscosity diminished in time—in some cases it was constant and in other cases not so. Where the viscosity diminished there was nearly always to be seen a little precipitate and in other cases where it increased there appeared to be a jellification. I would suggest to you as possible that solutions as dilute as possible should be used. The phenomena are most less pronounced in dilute solutions. If you take milk and squeeze it three or four times through a viscometer, you find a decrease in viscosity. Its viscosity gets less if you take diluted solution, and I should think it favourable to use in all cases as dilute solutions as you can possibly do.

Dr. SCHIDROWITZ: Could you suggest any limit?

Dr. OSTWALD: No, it will depend on the nature of the rubber you use.

Dr. SCHIDROWITZ: It depends on the nature of the curve. You cannot go below the critical point.

Mr. KELWAY BAMBER: Did you say you got your solution between 12 and 24 hours?

Dr. SCHIDROWITZ: As a rule.

Mr. KELWAY BAMBER: Our experiments in Ceylon tended to show that some of them took two or three days.

Dr. SCHIDROWITZ: Of what strength?

Mr. KELWAY BAMBER: One per cent.

Dr. SCHIDROWITZ: As a general rule I have not found much difficulty in getting a 1% solution. Some rubbers do dissolve more slowly than others. I am afraid I cannot agree with Dr. Spence that heating has no effect with *Hevea*. On the contrary, with *Hevea* you can obtain with heat a result in two hours which would take a day or two without heat. The heating, of course, affects viscosity one way or the other.

Mr. SUTER : Where different readings are obtained from samples treated in the same way, would the test point to the actual difference in the treatment. I take it you get different readings.

Dr. SCHIDROWITZ : Yes, we do.

Mr. SUTER : Would it be possible by a test to point to the difference in maceration or anything else which increases or decreases the quality of the rubber.

Dr. SCHIDROWITZ : There is no doubt the effect of excessive rolling and other physical treatment is brought forth in the viscosity. There is no question about that.

Mr. SUTER : So that would be a direct instruction to the planter how to treat it.

Dr. SCHIDROWITZ : Yes, I think where the planter is in a position to carry out viscosity tests on scientific lines it might be useful to him in controlling the quality of his rubber. I wish it to be clearly understood that I do not prefer the viscosity method to the vulcanisation method. I think the vulcanisation is the best method you can employ, but the viscosity method is useful where you cannot. It is also extremely interesting from a scientific point of view, and certainly the results obtained—I have many hundreds of them—indicate that there is generally a very distinct connection between viscosity and the vulcanising capacity.

Raw Rubber Testing.

By CLAYTON BEADLE and HENRY P. STEVENS,
M.A., Ph.D., F.I.C.

Note.—This paper was delivered as an evening lecture illustrated with lantern slides.

Part I.—Methods.

Rubber samples intended for testing arrive at the laboratory in a variety of conditions. They may be either clean or dirty, moist or dry, and, except in the case of clean dry products, the first treatment they should undergo is a thorough washing in an ordinary two-roll washing machine and the thin crepe is then hung to air dry out of contact with bright light. If the rubber is clean and dry it need not be washed. If desired, however, and for the sake of uniformity, it can be put through the washing rolls, but it never gets efficiently washed like wet rubber as the water is not absorbed to any appreciable extent during washing, and the rubber is almost as dry after surface moisture has evaporated as it was before it was washed. Even soaking the dry rubber for days previous to washing has little effect.

The raw rubber should be carefully weighed before washing. After washing and drying, the percentage loss, termed " loss on washing," is of course an important figure.

The washed dried rubber may be subjected to chemical analysis which is chiefly of value in the case of lower grade rubbers other than Para.

The chemical analysis of raw rubbers has been so fully discussed that we need not deal with the matter at any length. The usual determinations consist of the acetone extract, usually termed resins, the percentage of nitrogen calculated as a protein and the ash. In the case of a high-grade *Hevea* rubber a small variation in the resin or other constituents is of little or no value in judging the quality of the rubber. As a rule there is no need to determine the caoutchouc directly as the soluble carbohydrate constituents and coarse impurities are removed when washing.

The tests on which we mostly rely, particularly for high-class rubbers, are physical tests, carried out on the rubbers vulcanised under standard conditions. The vulcanisation should be carried out under the comparative test system, that is to say, the sample under examination is compared with a standard quality of a similar brand. The experimental results given in this paper will be illustrated by reference to a number of *Hevea* rubbers. These have been subjected to a series of tests both in

the raw and vulcanised state and the figures are available for comparison.

These tests may be summarised as follows :—

Hysteresis tests. Extension for 5 cycles } constant load tests.
Cyclic recovery
Cyclic remainder

Sub-permanent set (constant extension) tests.
Tensile strength and limit of extension tests.
Tensile-Impact tests.

All these tests are made on the vulcanised rubbers. The following are made on solutions of the raw rubbers :—

Adhesive power.
Viscosity.

The above tests, although fairly representative, are not complete. Our work on Tensile-Impact tests is discussed in another paper.

Rubber differs from other materials in its wide extension limit and consequently its behaviour under gradual extension can be studied with great accuracy. For this reason hysteresis tests are particularly interesting and we have found them to give a better insight into the quality of a raw rubber than other methods of testing.

Hysteresis Tests.—The apparatus used is a machine designed by Professor Schwartz and fully described in a paper before the Institution of Electrical Engineers, 1910, page 693, "The Testing of Raw Rubber for Electrical Work." One of the machines is here and you will have an opportunity of examining it after the lecture. We have adopted the method of successive cycles as described on page 715 of this paper, that is to say, the sample is stretched several times (we find 5 sufficient) under the application of a maximum constant load and measurements are made from the curves traced on the diagram.

Professor Schwartz designed his machine with a view particularly to testing cable coverings and he has been good enough to give us his assistance in arriving at suitable modes of expression for physical values. The samples tested are in strip form, but may be of any convenient length and sectional area, provided that the load applied is suitable for tracing curves of convenient dimensions on the available surface of the chart. As a standard, all figures are reduced to a strip of 1 sq. mm. sectional area and 100 mm. long so that measurements in millimeters give the results directly in the form of percentages. It is possible to work either to a load or an extension limit ; the former has certain advantages and we have adopted it. The load we have fixed at 200 grams per sq. mm., cross sectional area and we usually work with strips 50 mm. long between the grips, 5 mm. wide and 1 mm. thick. The expressions for the numerical values are as follows :—

1. *Percentage extension* or elongation produced by a load limit of 200 grms. per sq. mm. cross sectional area at first cycle.

This is really a measurement of the elasticity of the rubber and the reciprocal of the figure obtained expresses the resistance of the rubber to stretching under a constant load.

This figure, if desired, can be expressed as a co-efficient of elasticity, that is, as the force in grams required to stretch a strip of rubber of 1 sq. mm. cross section to double its normal length, assuming the rate of elongation as uniform with the load applied. Thus, taking a rubber showing an extension of 292 per cent. with a load of 200 gr., we have the co-efficient of elasticity

$$E = \frac{200}{2 \cdot 92} = 68 \cdot 2$$

2. *Cyclic fatigue.*—The term we use to express loss of power to support a given load and consequent progressive increase in length produced by the successive applications of the same maximum load. The numerical value can be obtained, as Schwartz has shown, by plotting the extensions for each successive cycle against the logarithm of the number of the cycle. Each specimen is then represented by a curve which is approximately a straight line. This we have found to be the case in a large number of tests, and have generally obtained a curve which is concave to the direction on which the extensions are plotted. Taking the curve as a straight line, the slope of this line will be a measure of the elastic fatigue, and to express this independently of the relative dimensions of the chart, the following expression may be adopted :—

$$\frac{\text{Length of specimen at 5th cycle—length at first cycle}}{\text{Log } 5}$$

As log 5 may be taken as ·7, it is an easy matter to subtract the extension at first cycle from that at 5th cycle and divide by this figure.

3. *Cyclic remainder.*—When a sample of rubber is stretched and the load subsequently removed, the specimen does not at once return to its original length, but is longer than before, stretching by a definite amount, namely, the sub-permanent set, or extension remainder as the physiologists term it. This remainder is, of course, greater after the specimen has been stretched five times, as in the successive cycle tests, and the increase in length may be conveniently termed "cyclic remainder," and is expressed as a percentage on the original length of the rubber.

4. *Sub-permanent set.*—The extension remainder or cyclic remainder is in other words a sub-permanent set, but we have reserved this term for a test carried out on different lines. In the first place, the sample in question is stretched to a constant extension limit, instead of a load limit, which we have fixed at 4 times its original length. This can be conveniently done by punching two holes in the strip 100 mm. apart, cutting away the rubber between the holes so as to produce a sort of elongated ring which is then stretched over pegs to the required extent. Any number of samples can then be tested at the same time, the pegs being arranged in parallel rows, one set on a fixed block and the other on a movable block. The specimens are kept extended for 24 hours. They are then released and measured after giving 6 hours for recovery and the percentage increase in length we term sub-permanent set. It may be noted that this differs from the cyclic remainder in that the samples are kept extended for a greater length of time and are also given a much longer time for recovery.

Tensile strength and extension limit tests.—During the past five or six years we have made a careful study of this type of test. Our early experiments led us to adopt a ring shaped test piece and the machine has been already described (Journ. Soc. Chem. Ind. 1909, page 1,111) therefore it need not be discussed in detail here. We will merely point out that this machine possesses advantages as regards simplicity of construction and in the use of a relatively small test piece, the cross sectional area to be ruptured measuring 5 sq. mm., which is ample, considering the strength of the material. The small test piece has the

advantage that it can be cut from a thin sheet from vulcanised goods of almost any shape or size. An excellent machine has been brought out by the firm of Schopper, which is built on the well-known lines of their other testing machines. It employs a ring-shaped test piece with the added refinement of a revolving pulley on which the rubber is stretched. Much larger test pieces are required for this machine and consequently more rubber. Thick sheets must of course be built up in plies from thinner sheets.

Messrs. Hinrichsen and Memmler have given figures to show that where the pulley of the Schopper machine is not made to revolve, the results are lower ("Der Kautschuk und seine Prufung," p. 185). This, however, is only of secondary importance when comparing different rubbers, the required figure being merely relative, not absolute. The conditions under which a ring is stretched when the pulley is not made to revolve or where rounded hooks or pegs are used in the place of pulleys really accord more with the actual conditions under which rubber goods are subjected in every-day use.

In carrying out our tests we punch rings from a sheet of rubber 1 to 1½ mm. thick. The rings have an external diameter of 5 mm. and an internal diameter of 2½ mm. For other details see our Paper before the Journal of the Society of Chemical Industry above referred to.

Adhesion Tests.—In the proofing factory, a rough test is frequently applied to determine the quality of rubber solution which consists in spreading a layer of the raw rubber in naptha on the surface of a strip of cloth and allowing the naptha to evaporate. The cloth is then doubled over so that the spread surfaces come in contact and when pressed together become practically one layer between two layers of cloth. The strip is suspended at one end, and if the rubber is satisfactory, must support a certain weight at the other end before the adhering surfaces are torn apart. This procedure has been adopted by the Admiralty for testing the quality of rubber solution.

In this test much depends on the manner in which the strip is suspended and the weight applied. No clamp of any kind is mentioned in the Admiralty specification and unless the two ends be so adjusted that the strain is evenly spread along the full width of the cloth the results will not be satisfactory.

We have made a series of experiments with a view to modifying this test so as to make it sufficiently reliable and accurate to be used for comparing solutions of different rubbers. We first reduced the width of the cloth to 2·5 cm. so that its whole width could be grasped in the clamp of our testing machine, and, as far as possible, avoid uneven strain. We had difficulty with fraying of the edges and it was not found possible to cut the strips of an even width without cutting both warp and weft. Ultimately we abandoned cloth for a thin strong, fairly smooth paper, such as a type-writing paper of the nature of Wiggin & Teape's extra strong. A sheet of paper of ordinary quarto size is lightly creased down to middle to facilitate subsequent folding. A pencil line is ruled parallel to and 5 cm. distant from the crease. The rubber solution is either applied with a brush or the sheet is drawn over the surface of the rubber solution in a large flat photographic developing dish so as to coat the surface to a distance of well over 5 cm. on either side of the crease. In practice it is most convenient to coat the whole of one side of the sheet excepting the end held by the fingers which is then fixed in a paper clip and hung up so that any excess of solution may drip off and the benzene (or naptha) may evaporate. The sheets

should not be hung longer than is necessary and in a room free from dust. When dry the sheet is folded along the crease and the rubber coated surfaces brought in contact as far as the pencil line, the remainder being prevented from adhering by the insertion of a sheet of plain paper up to the line. The two surfaces are made to adhere thoroughly by pressing together with a light roller, and one end is then folded back along the pencil line and any exposed rubber surface beyond that is prevented from adhering by dusting over with French chalk. Test pieces 2·5 cm. wide are now cut from the sheet with a pair of scissors or knife. One sheet will yield eight or nine test pieces, so that two sheets prepared in this manner are ample for a full test. The results from each sheet, say five tests each, may be kept separate and the mean of each five should agree closely. This gives a satisfactory check on the results. Any ordinary tensile testing machine provided with grips may be used.

So far as regards the preparation and actual testing of the strips everything is plain sailing, the difficulties arise in the preparation of the solutions. These are just the same difficulties that are met with in viscosity determinations. However one proceeds it is a practical impossibility to prepare two solutions from the same rubber exactly alike, and it remains to be seen whether they are nearly enough alike for practical purposes. There is the further difficulty of devising a means of preparing solutions equally applicable to all types of raw rubbers, restricting ourselves to rubbers of the same botanical origin.

The following alternatives may be considered :—The solution may be prepared from the dry raw rubber (*a*) without previous treatment, (*b*) after passing once or twice through cold rolls to reduce it to the form of thin crepe, if not already in this state, (*c*) after mastication between warm rolls.

Whichever method be adopted the solution prepared must be uniform and free from swollen half-dissolved lumps which give it a stringy appearance, particularly noticeable when a little of the solution is taken out on a glass rod and allowed to flow back again. The only one of the above methods which gives a satisfactory solution with *all* classes and grades of Para rubbers is method (*c*). The rubbers should not be masticated for the same length of time, but until the operator judges the right consistency has been obtained. It may be argued that all samples should be treated exactly alike, but this would not be giving them the same treatment as some of the rubbers may have been worked to a greater or less extent before sending to the testing laboratory, and would, therefore, get a double working, which would place them at a disadvantage as compared with rubbers received in the form in which they were coagulated.

Method (*a*) is only suitable for quite a limited number of rubbers, a uniform solution cannot usually be prepared in this fashion. Some rubbers even when cut into thin shreds retain their shape after twelve months in naptha. Method (*b*) is also applicable in a limited number of cases, but an even running solution is not usually obtained except after a good deal of mechanical treatment in the form of shaking and stirring. This in many cases is so prolonged that it can only be carried through by a suitable mechanical contrivance, and it is difficult to decide just when to leave off, while the longer the treatment is kept going the lower the viscosity.

In the second part of this paper figures will be found obtained by tests made both by methods (*b*) and (*c*).

In spreading a thin layer of solution by the method already described, the less viscous the solution, the more of it will drain off and the thinner the layer. Within the limits we have worked with the adhesive power increases with the thickness of the layer, but much more slowly. Hence rubbers giving more viscous solutions will give slightly thicker layers, and consequently rather higher figures than those giving less viscous solutions.

Viscosity determinations.—Axelrodt was the first to suggest that the viscosity of a rubber solution could be generally employed as a measure of quality. It has always been a well-recognised fact that low grade, highly resinous rubbers tend to give thin solutions while high grade rubbers give highly viscous ones. The list of figures published by Axelrodt does not take us much beyond this stage. Axelrodt tested a great variety of rubbers, and although some of the best were among those giving the most viscous solutions, other good class rubbers were to be found giving relatively low figures.

Schidrowitz and Frank attach great importance to viscosity as a measure of quality, indeed the latter author places it in the forefront of all methods.

Raw rubber does not consist only of bodies mostly caoutchouc and resins soluble in naptha, but also of insoluble substances present in small amount, and as shown by Spence with a highly nitrogenous content. They are of protein nature and have a macroscopic, possibly also a microscopic structure. They can be examined, as we have found, by taking the sediment which has settled out from a thin solution on long standing or the skeleton of a shred from which most of the caoutchouc has dissolved, and staining with eosine. The protein is apparently separated during coagulation and forms a network throughout the rubber. These films or threads comprising the network are probably impervious to benzene and other organic solvents and, therefore, hinder the solution of the rubber, that is, hinder the formation of an even flowing, homogenous fluid. Portions of caoutchouc enclosed in pockets of protein matter may never be properly disseminated throughout the bulk unless the protein be broken up by mechanical working.

This view is supported by the fact already mentioned, that small pieces of rubber may remain many months in benzene and still retain their original form and the swollen pieces will be found richer in caoutchouc than the rest of the solution. It also explains why rubber dissolves more easily after mastication which breaks up the protein films, and also why a rubber solution becomes thinner and less viscous on standing.

We have had 1 per cent. solutions of different rubbers in benzene under observation for nearly two years, the viscosity was determined from time to time and continually fell away until all the insoluble matter had settled out, *after which the viscosity has remained constant.* The experiments were carried out with an Ostwald's viscometer. Unless the insoluble matter is sufficiently disintegrated by mechanical treatment, such as by washing the fresh coagulum, mastication of the rubber, or other means it has a very marked effect on the viscosity. This will also vary with the type of viscometer employed ; that is to say, whether the determination is made in an instrument with a long narrow capillary such as the Ostwald viscometer (Schidrowitz), or with a relatively short wide one (Axelrodt). In the former case the insoluble matter must either be broken up, if not already disintegrated, or else the skeletons of the original rubber shreds as obtained with sheet or biscuit

rubber must be filtered off through glass wool. In this case part of the rubber is retained by the glass wool.

Axelrodt thinks the insoluble matter should be retained in the solution as it represents the "nerve." This appears to us improbable; in any event the insoluble matter will have a varying effect on the viscosity according to the extent to which it has been broken up. Unfortunately its removal in all cases where the rubber has been mechanically treated is a long and tedious process, depending on its settling out. This may take months. We find the settling may be accelerated, although not to any great extent, by keeping the solution warm. Sometimes the insoluble matter is in such a fine state of division that it cannot be detected macroscopically in the freshly made solution. On allowing such a solution to stand we have always found a deposit form in course of time. Every specimen of raw Para rubber must contain a proportion of this insoluble matter, although the amount will differ according to the method of preparation from the latex.

In the first place then the insoluble matter has a disturbing influence on the viscosity determination of the actual caoutchouc, and in the second place there is no generally applicable method for its removal without allowing the solutions to stand a long time. The one course open is to masticate the rubbers sufficiently to break up the insoluble matter so that its structure no longer exerts any appreciable influence on the results, the other course is to use a viscometer with a short wide orifice; but as will be seen from the figures given in the second part of the paper the results obtained by the two methods are not in agreement.

PART II.—RESULTS.

Having defined our terms, we will now proceed to give the results of hysteresis tests on a number of raw rubber specimens followed with tests by other methods.

For these experiments we used some ten different rubbers of which samples 4 and 6 consisted of washed fine hard Para rubber from different manufacturers, while the remainder consisted of plantation Hevea rubbers.

The dry rubbers were mixed, sheeted and vulcanised under identical conditions in the ordinary manner. They were cured side by side in steam between layers of cloth round a drum. Two or three cures were made and the results obtained on testing the specimens from each cure were found to confirm one another. The figures obtained are given in Table I. below. This table also includes the figures for Sub-permanent Set.

TABLE I.

Hysteresis Tests for Comparison with Viscosities, etc.

Order of Merit and No. of Sample.	Extension 1st Cycle.	Extension 5th Cycle.	Cyclic Remainder.	Cyclic Fatigue.	Sub-permt. Set.
1	292·0	459·6	29·2	23·9	6·9
2	302·0	464·8	30·0	23·2	6·3
3	306·8	480·8	37·6	24·8	7·5
4	356·8	554·0	45·2	28·2	7·5
5	376·4	603·6	48·8	32·4	12·9
6	416·4	659·2	60·0	34·7	8·4
7	424·4	669·6	65·2	35·0	17·7
8	421·2	686·8	64·0	37·9	16·8
9	432·0	688·0	75·2	36·6	19·2
10	416·8	657·6	79·2	34·4	24·0

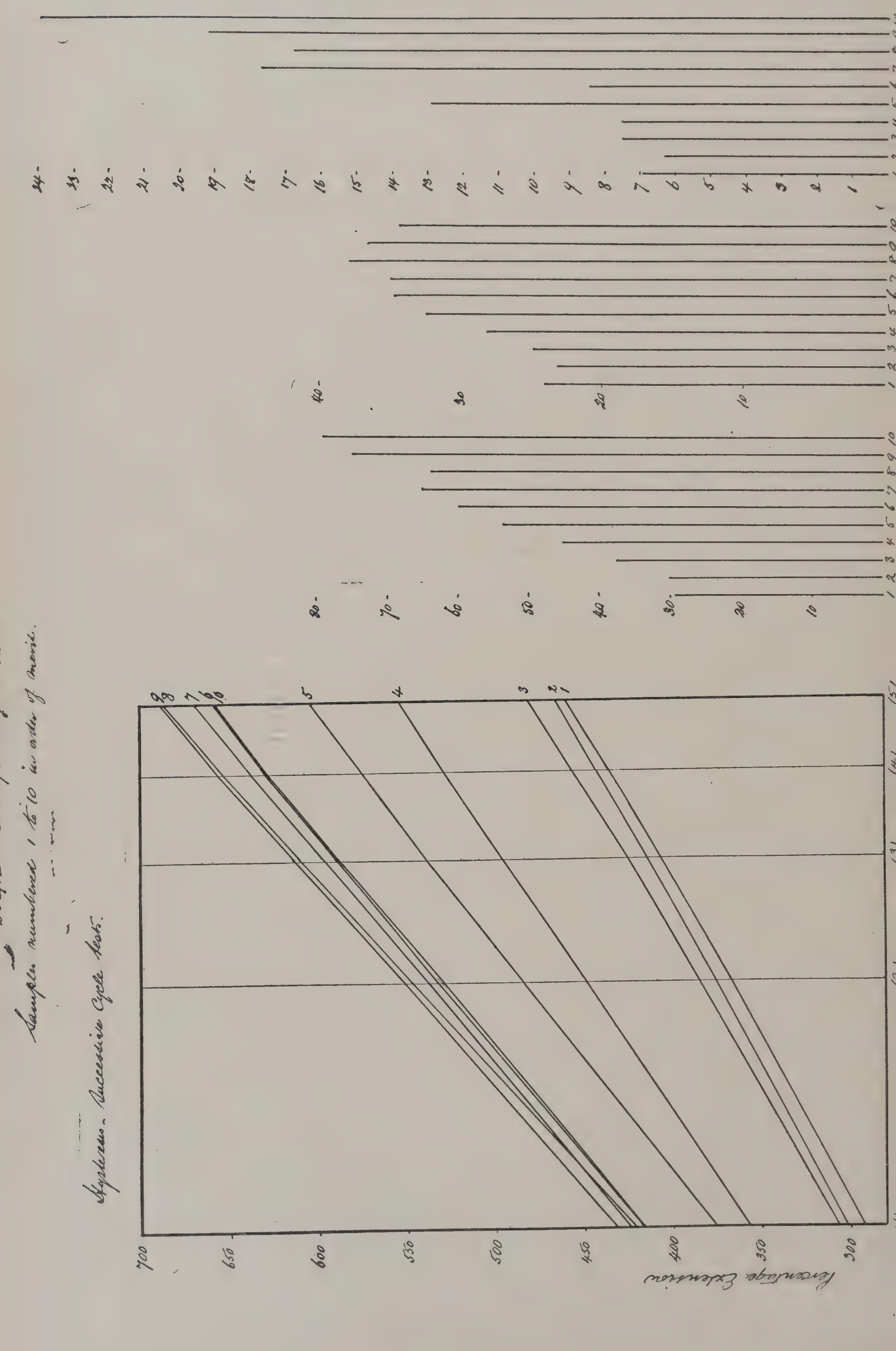


Diagram corresponding to Table I
Samples numbered 1 to 10 in order of merit.
Hysteresis. Successive Cycle tests.
Percentage Extension

We have numbered the samples in order of merit. The first two samples run each other very close, the first sample is a little the stronger. For practical purposes it might be preferable to bracket the two samples together and we should be prepared to leave the decision of the relative quality to the subsidiary tests described later.

The next two samples 3 and 4 fall into their positions without question, each sample giving inferior results in all tests to the preceding one. The same applies to number 5 in the hysteresis tests, while the sub-permanent set is rather greater. This is partly or wholly due to the use of an extension limit as against a load limit, already referred to in the earlier part of this paper. No 6 is a good specimen of fine hard Para and we have found that rubbers of this class give relatively better results as regards the sub-permanent set than in hysteresis or tensile strength tests.

It is more difficult to fix the relative merit of the last four samples. They are all distinctly inferior to the preceding six. Numbers 7 and 9 are from the same estate and were prepared in the same form. Number 7 is distinctly the better of the two in all tests and there is no doubt that No. 7 should precede No. 9. A comparison with number 8 is more difficult, owing to certain differences in the order of the figures. It is slightly better than No. 7 in the resistance it offers when first stretched and as regards recovery after allowing to retract, but it is distinctly inferior as regards the cyclic fatigue, in this respect showing the worst figure of any of the samples tested. With this exception it is well ahead of sample 9.

The sample at the bottom of the list is one that we have had under observation for some time. In the figures given above it appears distinctly inferior to the other samples in respect to its power of recovery after stretching. The figures for cyclic extension both first and fifth cycle are better than the preceding three samples, but the differences here are relatively small.

To sum up, the results of these tests show the first four samples are undoubtedly ahead of the others and the first two of these could be bracketted equal. The next two samples are inferior to the first four and superior to the last four, and of these latter No. 7 is certainly better than No. 9.

Tensile Strength and Extension Limit (*Distensibility*) *Tests.*

The results of these tests are given in Table II., placing the samples in the same order as before :—

TABLE II.

No. of Sample.	Tensile Strength per sq. mm. cross-sectional area of test piece.	Extension Limit when original length of test piece = 1.	Tensile Strength per sq. mm. cross-sectional area when fully extended.
1	524	9·9	5,190
2	580	9·9	5,730
3	445	9·2	4,090
4	432	10·1	4,370
5	410	9·5	3,900
6	337	10·4	3,520
7	315	9·2	2,900
8	355	9·8	3,480
9	290	9·2	2,650
10	318	9·4	2,990

The last column is the best guide as to the quality of the rubber. It is the product of the previous two columns.

If we compare these figures with the order in which the samples were placed from the Hysteresis figures it will be seen that we find this order the same in the great majority of cases, but (*a*) the order of the first two samples is reversed; the elongation limit is the same but the tensile strength of 2 is greater; (*b*) rubbers 7 and 9 drop out of their order and now follow 8 and 10. It will be remembered that 7 and 9 were similar rubbers from the same estate. The extension limits are the same but 7 is stronger than 9. That is to say, 7 is the better sample of the two as in the Hysteresis Tests.

With these modifications it may be said that the tensile strength tests confirm the conclusions drawn from the hysteresis tests in particular, the figures for the extensions first and fifth cycles so that the tensile strength is roughly proportional to the resistance a rubber offers to stretching. On the other hand there is no close relationship between the tensile strength and the elastic fatigue as measured by the cyclic remainder and sub-permanent set. The hysteresis curves have then this advantage over the tensile strength tests that they give figures which allow conclusions to be drawn both for the elastic fatigue (recovery after stretching) and the strength of the rubber while the tensile tests give figures for the latter only. These conclusions, although based here on the tests recorded have been confirmed by numbers of similar tests made in our laboratories. Hysteresis tests have the advantage that they can be made with very great accuracy, the error on a repeat test does not usually exceed 1 per cent., while tensile strength tests vary from 5 per cent. to 20 per cent. when repeated; indeed, at least ten separate tests must be made and the mean taken to arrive at an approximately correct figure.*

Adhesion Tests.—These tests were carried out with 5 per cent. solutions prepared both from masticated and unmasticated rubbers by weighing out rubber and solvent directly into vessels and shaking the contents from time to time over a period of three days to obtain a solution as uniform as possible. The rubber was masticated to about the same extent as would be required for an ordinary mixing. The solutions were smooth and flowed evenly. The rubber which was not masticated did not give such even flowing solutions in the majority of cases. The sheets of paper were coated by drawing over the surface of the rubber solutions and hung up to dry. In the case of the unmasticated rubbers a weaker solution was used, as a 5 per cent. solution would not flow sufficiently. The results are given in Table III.

TABLE III.

Sample Number.	Weight in grams required to separate surfaces. Masticated.		Unmasticated.
1	434		403
2	395		398
3	339		—
4	375		409
5	433	437	405
5 (second test)	441		—
6	391		422
7	281		395
8	310		391
9	277		420
10	419		428

Each figure is the means of ten separate tests.

* See Memmler uSchob Mitthcilungen aus dem Kgl. Material-prüfungs Amt, 1909, vol. 4, page 101.

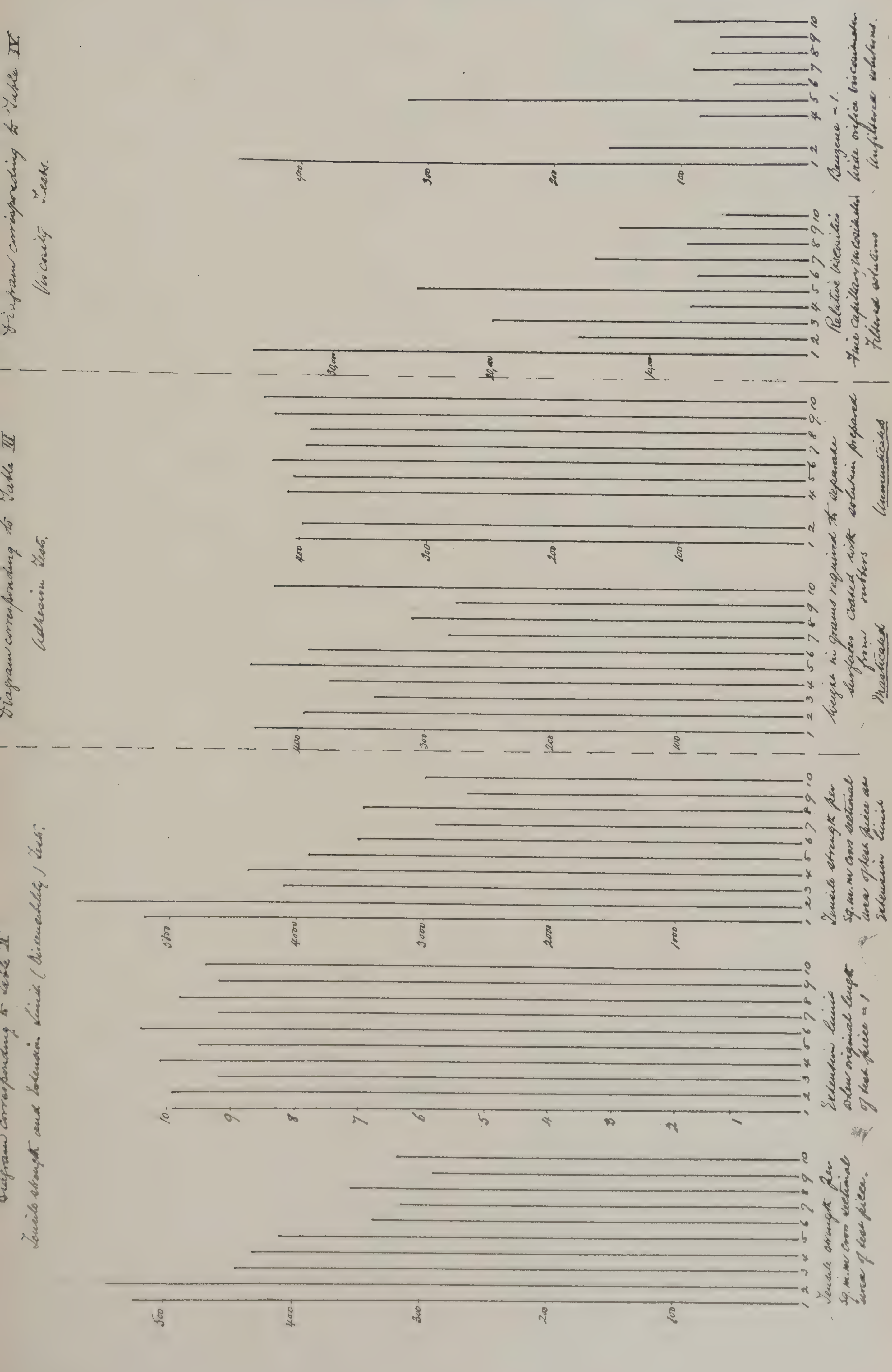


Diagram corresponding to Table II.
Tensile strength and Extension Limit (Distensibility) Tests.
Tensile strength per sq. m.m cross sectional area of test piece.
Extension limit when original length of test piece = 1
Tensile strength per sq. m.m cross sectional area of test piece at Extension limit
Diagram corresponding to Table III
Adhesion Tests.
Weight in grams required to separate surfaces coated with solution prepared from rubbers
Masticated
Unmasticated
Diagram corresponding to Table IV.
Viscosity Tests.
Relative viscosities
Fine capillary viscosimeter
Filtered solutions
Benzene = 1.
Wide orifice viscosimeter
Unfiltered solutions.

The figures show that mastication influences the adhesive powers according to the quality of the rubber. Samples 1 to 5 are mostly improved in this respect by mastication, while samples 6 to 10 all lose adhesive power by mastication. With this exception, it cannot be said that the adhesive qualities of the raw rubbers bear any direct relation to the physical qualities of the vulcanised rubbers. Of the two series, the first (masticated) accords better, and this also corresponds better with actual practice, but Nos. 4, 5, 6 and 10 give too high values in comparison with the others.

With regard to the appearance of the separated surfaces, the rubber appeared to be torn evenly, a little piece tearing first from one side and then from the other, leaving about the same amount of rubber on the two separated surfaces. This corresponds to what happens in the mill test where cloth is used. To get this effect the coatings must not be too thick—about ·001 to ·005 grams of rubber per sq. cm. of surface is sufficient.

Viscosity Tests.—The first series of viscosity determinations was made on solutions of concentrations from ·70 per cent. up to 1·45 per cent. Four or five determinations were made at varying concentrations between these limits, curves were plotted and the relative viscosity as compared with benzene calculated on the lines of the work carried out by Schidrowitz (Journ. of Soc. of Chem. Ind. 1909, page 3). The solutions were prepared from stronger solutions made from the rubber reduced to the form of thin crepe. These were allowed to stand two months in an air-tight vessel out of contact with the light during which time the insoluble protein matter had largely settled out. Previous to testing the dilute solutions were filtered through cotton wool.

In the second series of experiments solutions of 3 per cent. strength were prepared direct by weighing out the rubber and naptha. The rubber was previously reduced to thin crepe by passing two or three times between the rolls and the solutions were shaken up from time to time over a period of five days previous to testing, so as to obtain as uniform a solution as possible. Care was taken to treat all solutions exactly alike.

The viscosity determinations were made by means of a 20 cc. pipette of which a part of the delivery end had been cut off and having an outlet tube of approximately 5 mm. bore. The solutions were not filtered and no steps were taken to exclude insoluble matter. The tests were, therefore, made on the lines laid down by Axelrodt and correspond roughly with procedure as recommended by Frank.

In Table IV. are given the results of the determinations by the two methods.

The agreement between the two series of tests is confined to the first four samples and the figures are roughly proportional for the first three. As to the remainder there appears to be no correlation of values.

The differences observed are due entirely to difference in the details of preparation of the solutions. The actual determinations of viscosities can be done with considerable accuracy as repeat observations show. In the first series a glance at the figures and curves plotted from them leave no doubt as to the order of merit whatever be the exact figures as calculated, and as to the second series a repetition of viscosity determinations on the *same* solutions gave practically identical results.

Judging from comparison of the figures with the results obtained by other methods we are inclined to prefer the first series. Reference

has been made to the fact that samples 7 and 9 were similar samples from the same estate, and might, therefore, be expected to yield similar results, as indeed was found to be the case in all tests on the vulcanised rubbers, No. 7 always giving results a little better than No. 9. Compared with samples 8 and 10 they differed rather sharply in giving less resistance to stretching (see first and fifth cycles in Table I.), lower tensile strength and smaller extension limits (Table II.). They are also less adhesive in the masticated condition (Table III.).

On the other hand their viscosities are almost twice as great as those of Nos. 8 and 10, taking the figures in Table IV., Series I. In agreement with previous tests No. 7 gives a more viscous solution than No. 9.

TABLE IV.

Relative Viscosities Benzene = 1.

No. of Sample.	Series I. Viscosity of Rubber Fine Capillary Viscometer. Filtered Solutions.	Series II. Viscosity of Solution Wide Orifice Viscometer. Solutions not Filtered.
1	35,080	460
2	14,400	156
3	19,850	—
4	7,450	84
5	24,600	315
6	6,950	58
7	13,400	90
8	7,650	75
9	11,920	68
10	5,170	105

Both series of viscosity tests place sample 1 at the head of the list, followed rather closely by sample 5. We cannot find any parallel to this order in the tests on the vulcanised rubbers. On the other hand, the adhesion tests with the masticated rubbers also give an exceptionally high figure for No. 5. This rubber would appear to have certain qualities in the raw state which are not apparent when vulcanised, and we have made up mixings and vulcanised samples afresh, but with the same results as before, namely, that the figures were not so good as those obtained for the previous four samples.

In conclusion, we may summarise the results of the foregoing tests as follows :—Different methods of testing the *vulcanised* rubbers show fair agreement, particularly the resistance to stretching and tensile strength tests. On the other hand, tests on the raw rubbers, whether adhesion tests or viscosity determinations, lead us to different conclusions, according to the experimental procedure adopted, and although certain relationships can be detected, the general results are not in correlation with the results obtained by vulcanisation tests.

The CHAIRMAN : I think very likely that those who have listened to this paper will feel as I do that Dr. Stevens has performed a very difficult task. When one embarks on a line of work of this kind it is impossible to go very far without drifting outside the line of the ordinary individual's thinking. That is, though it seems to you that you are following on in perfectly straight and consecutive order to certain definite results, which it seems to you no one can help seeing, yet if you stop and compare your state of mind when your investigations have proceeded some distance with the state of your mind when you began,

you will realise that you have unconsciously lapsed into more complication than you think you have. The thing is perfectly clear to your own mind, but when you come to try to make someone else understand it, it is very difficult. Therefore, I fancy a good many of you feel as I do, that in order to discuss and weigh this paper adequately it will be necessary to add considerable study. Nevertheless, there are some points that have occurred to me, and may have occurred to you as the lecturer proceeded, where a question might be asked from which, or acting on which, Dr. Stevens might perhaps make some points a little clearer than we were able to get it at the first blush. I hope, therefore, we shall have a number of questions asked and as much discussion as is possible in the time available. Perhaps Dr. Schidrowitz would start the discussion.

Dr. Schidrowitz: I have listened with the greatest interest to Dr. Stevens' paper, and I think you will all agree that he has succeeded in covering a very wide range of subjects—for there are a number of subjects involved in his paper—in a short time and in an admirably lucid and clear manner. Indeed, it appeared to be so to me, but that may be because I have been occupied with some similar subjects for a number of years past. It would be impossible to deal exhaustively with all the points raised because they cover the wide range of the whole of crude rubber testing and of vulcanized rubber testing, subjects which would already fill several large volumes and will in the future fill a fair sized library. At the same time there are one or two points on which I should like to make a few remarks and ask a few questions. The first point is, "Does Dr. Stevens in his paper describe a standard method of vulcanization, and does he suggest that a standard method should be applied, or should every rubber be vulcanized from the point of view of the best result it will give?" At first blush it would seem that one should vulcanize every rubber over a range of temperatures and heats to get the best results, and that seems the best thing to do. On the other hand, you have the manufacturer who looks at rubber from the point of view perhaps of a standard mixing, and he says, "I do not want to be bothered by going through a long range of experiments; I want to know how it will work in a standard mixing. If you have a standard method that can be applied that would be fair from one point of view, unfair from another. I should be glad to hear Dr. Stevens' remarks on that subject. I may say that whenever I have a new type of rubber to examine, I go through the whole range; but that is rather impracticable if one is going to apply the method to the ordinary testing of plantation rubbers as they come into the market, and I think that for this class of rubber we should look rather to a standardised type of testing. I think we have all had the experience that many plantation rubbers give excellent results, results better than Para, and vulcanize readily, while others give a lot of trouble and are not so good as Para. Then with regard to viscosity, I quite agree with Dr. Stevens that this method gives one very important and valuable result. It will be a valuable test and gives us a deep insight into rubber. Personally, I am inclined to think that the method is described by Dr. Stevens for the hysteresis test does not go quite far enough. The load he applies, while it may give us a fair idea in the case of low grade mixings, does not give anything near the limit of what a high-class mixture will do. In making hysteresis tests I prefer to go to about 70 per cent. of the breaking strain of the rubber. With high-class rubbers it is not until you get near to the break that the characteristic nature

of the curve appears. I cannot agree with Dr. Stevens that the method of testing with non-rotated rings corresponds more closely to what occurs in practice than the method employing a rotated ring. I think that for a method of that sort you want to get as near as possible to absolute results. Such observations as I have been able to make show that the results with rotated rings are far more even and comparable with one another than with the non-rotating ring. Now, with regard to the adhesion test, that is a kind of testing which is in its infancy. No doubt we have all made adhesion tests and used particular methods which mean something to us. Dr. Stevens' method will indicate to him what his particular rubber is doing; and another observer's method gives a series of results which mean something to him. Therefore, one does not incline to be dogmatic on that point. I do not feel inclined to be dogmatic as to any method or to advocate too rigid a standardisation. We should all be careful not to advocate standard methods beyond certain limits, but should get the best results we can and then discuss the various methods and results we arrive at, and if we are all agreed on a certain method let us adopt it. With regard to the viscosity determinations, I should like to point out first that the viscosity determinations of axelrod, which were carried out with a wide orifice, were not viscosity measurements at all. It is one of the essential elements of viscosity measurements that there should be no turbulent flow, and the maximum orifice at the outlet which will give you a non-turbulent flow can be readily determined mathematically. I may say that the orifice of the "viscometer" used by axelrod is far beyond the limit. I do not say that measurements made with wide-orifice viscometers have not some relative value; I have no doubt they have, but I should advocate that we should reserve the term *viscosity* for that which is a scientific viscosity measurement. Dr. Stevens spoke of insoluble matter deposited on standing from "bright" solutions, as if this were insoluble matter originally present; I think that is only true to a limited extent. Some interesting experiments were made on that point by Wondstra, who showed that the deposition which takes place is not a deposition of insoluble matter but a flocculation such as takes place in every colloidal solution. It is, therefore, a little difficult to gauge the point at which this so-called deposition ceases. In fact, it never does cease. I have made viscosity determinations for three or four years, and it is one of the routine determinations I now carry out. I find no particular difficulty in getting a solution of sufficient concentration to determine viscosity at the various necessary points. If the insoluble matter leads to high results you would expect to find that rubbers containing a large amount of insoluble matter would generally give high viscosity figures. I have frequently found the results the exact contrary. Then Dr. Stevens showed us one rubber which gave a viscosity figure according to the method of calculation suggested by one of 35,000, but I think he had masticated that rubber. I think he said he reduced it to crepe. That breaks up the mechanical structure and creates difficulties in regard to filteration. Speaking broadly, I have not had any difficulty in that way, but I do not mechanically work the samples. I quite agree with Dr. Stevens that the best method of testing rubber is by vulcanization, and wherever it is practicable that is the most desirable way. If you have got to put ordinary commercial consignments through the vulcanization test you have got to be able to do it in a couple of days at the outside. That means vacuum drying at high temperature, and somewhat severe mechanical action. It means that you do not give your rubber time

to recover from washing, drying and mixing, and it means that you do not get the best results you can get. I do not say this is fatal by any means—certainly not. I say as a relative test it is a very good one, although the results are purely comparative. If you have one rubber ha[illegible]aks down more than another, that is so much the worse for the rubber. In a sense it is a measure of the relative commercial value of the rubbers. If you make your tests on a standard line of that sort, very useful results are obtained. But that is out of the question on an estate where you have not complete vulcanization plant. In that case the viscosity test is a very useful one, especially if always carried on in the same way, to give the plantation manager some idea of the way his material is being kept up to the standard; and whether it is being turned out in a proper fashion. I have found that the viscosity measurements correspond very fairly, on the whole, with the vulcanization tests. I do not say we do not get anomalies occasionally. They do occur, but when all is said and done, the fact, in my opinion, remains, that the viscosity test is a very useful auxiliary to the vulcanization test. So where the vulcanization test is out of the question the viscosity test is the more rapid and the most convenient. I am not surprised Dr. Stevens did not get any considerable correspondence between the viscosity test carried out by the methods of axelrod and my own respectively, because, as I have pointed out, the axelrod method does not give you "viscosity." One thing struck me about Dr. Stevens' tensile results: that is that all the figures for breaking strain are very low. That, of course, means that all the rubbers examined must have been fairly low grade material. Because with high grade rubbers (a breaking strain of 500 grammes corresponds to about 700 lbs.) one would expect with high grade material anything from 1,200 lbs. to 3,000 lbs. and more.

The Chairman: Per square inch?

Prof. Schidrowitz: Per square inch. It would be interesting to know if Dr. Stevens has any figures of high grade material, because when you get down to these low grade materials you get a different type of curve—you get down to where the rubber is de-natured and where the characteristics of the rubber are not visible.

Mr. J. Ryan (Ceylon): I must thank Dr. Stevens, being myself a simple garden planter, for the way he has tried to enlighten my ignorance. It has been my province for years to try and test rubber. I have invented machines, but until I came here I had not the remotest notion as to how the thing was to be adequately done. We have to thank him for having shown us how in the future we may possibly find some relation between the sample of rubber and the price we ought to pay for it. I will not venture to go into the points raised as to milligrammes and tensions and strains, but I thank Dr. Stevens for having shown us to-night how we are on the threshold of practical results.

Mr. F. Martin: I wish to endorse the chairman's remarks as to the complexity of this study, and I thank Dr. Stevens very much for tackling this matter. It is one that will affect the buyer of rubber as well as the manufacturer; and in that respect I am going to ask Dr. Stevens if he would give us some idea as to the time it would take to apply tests to a sample of rubber, because that is the important point to the buyer. With regard to the point as to preparing the solution for making the tests, it occurred to me that since the physical treatment of the rubber affects the solution, or swelling up of the rubber to such an extent, and admitting there is a definite relation between the time of solution of the rubber in any solvent and the physical condition of

the rubber, it seems to me that at this stage of the inquiry it might be interesting to get some relative results as to rubber worked to a definite strain in the mixing mill before it is presented to the solvent. You would then, at least, have a comparison of results under the known definite working in the manufacturer's shop. Then with regard to the paper test, another point occurred to me. Different papers vary as to so-called capillary action. I understood Dr. Stevens to say that the paper was simply drawn over the solution. Now, as one who has looked into the manufacture of paper, I know that it is quite impossible to take a square metre of paper and cut a dozen or fifty pieces of paper and find the same physical condition over all of them. There will be a difference in the rate at which adhesions will take place in that paper. It seems to me that since this test might be developed to be an important one, it would be well to start out with a piece of paper which is of absolute surface composition throughout the area of paper taken.

Mr. Clayton Beadle: I do not wish to anticipate anything that Dr. Stevens may say in his reply, but being associated with Dr. Stevens in this work and having had a good deal to do with the manufacture and properties of paper, I may throw some light on the remarks of the previous speaker. It is the question of the amount of adhesion between the surface of the paper and the rubber, and the adhesion of the rubber particle. If the strip adheres to the two surfaces of the paper, so that the rubber leaves its two surfaces upon the paper, then the question of the properties of the paper, I think, does not arise at all. If the paper is sufficiently sized, of course, it can be made of very uniform quality. We have tested various qualities of paper for this purpose. If the paper is sufficiently strong not to be broken, and if the rubber forms a film on the two surfaces, we get the true value of the test. In regard to the use of a ring. At the reading of Prof. Schwartz's paper it occurred to me to suggest the use of a ring, and I believe he has since tried a ring, but has not found it very successful. It occurred to me the ring might more truly indicate the physical quality of the rubber as representing the strength and physical qualities of the rubber, not in the one direction of the strip, but in all directions. When a substance like rubber is rolled out in a sheet, provided the strips are taken in a definite direction, it possesses definite qualities in that one direction, so that all qualities treated in that direction are comparable. But when strips are taken at right angles or in other directions to the main direction, then one is likely to get other figures. It appears, therefore, that a ring which takes into consideration different directions in the one operation would be more likely to represent the average qualities of the rubber than tests on a strip taken in the one direction only.

The Chairman: I think we must now draw the discussion to a close, remembering that we are going to hear Dr. Memmler's paper to-morrow on another part of the subject. A great many of the tests brought before us to-night are of great interest to the producer of raw rubber everywhere, but no one paper can answer the multitude of questions connected with the matter of raw rubber tests. I fancy when we come to tests bearing on manufactured rubber goods, where we are dealing with vulcanized articles, many of us will feel we are on dry land again, but when we approach the question of tests made on raw rubber itself, and undertake to devise a series of tests by which a planter can so value his rubber that when it goes into the market he will find he has valued it on a standard which will agree with the manufacturer's standard. I do not think any of us fully realise what we are undertaking.

I am rather inclined to question the advisability of using test pieces of such small sectional area. In case of other materials we find them misleading, and I am inclined to think they will prove so here. Of course, this point has more force in case of breaking tests than in case of hysteresis tests.

Dr. STEVENS, in reply, said: Perhaps I may begin with the questions asked by the Chairman. I am afraid there is some misunderstanding. It is not suggested that any of these tests should be made on plantations. I do not think that would ever be practicable; it would be much better for planters to continue to do as they are doing, namely, to send their rubber home and have it tested here. As regards metric units, if the tests are to be interpreted subsequently to the planters, it follows that we can make the tests in any units provided we interpret them in a manner understood by the planters. The gentleman who regarded himself as a working planter seemed to be very grateful to me for something.

Mr. RYAN: I was grateful that there was being a standard set on the other side.

Dr. STEVENS: As regards standards there has been a good deal of discussion, and I may reply to it collectively. The vulcanizing test have been described; these are the standard tests that we make, but we do not for a moment wish to impose them as a standard on other people. Everyone who works in these things has his own methods of testing and interpreting results, and it is not for a moment suggested that other people should adopt these methods. We merely give a description of the methods and the results obtained, in the hope that they may be generally useful. That makes it difficult for me to go into the question of a standard vulcanizing test. Personally, I feel that we are very much in the dark as to the physical properties and behaviour of rubber under different circumstances, whether raw or vulcanized; and I would hesitate to suggest now any standard test. I doubt whether at this stage it would be wise to propose any standard test, however carefully it might be drawn up. If it is necessary to have some sort of guide, it is possible to lay down certain general lines on which we could work, but I think we have not yet sufficient knowledge on which to base standard methods which would be useful. There is also some misapprehension as to the adhesion test. We do not look at them as being necessarily of great value; they have a certain value, but we do not suggest that they could replace the others. They would not be of the value of the vulcanization tests. They are a refinement on the rough test which is made in every mill with rubber solution. That was why we made some experiments with it. Another speaker asked as to how long it would take for tests to be made. We must first ask, "Is the rubber clean and dry?" "Is it like the majority of the first latex from plantations which can be put straight into the mixing machine and masticated?" If that is so, the test can be put through in a couple of days, but more accurate results would require a week to a fortnight. But we have on occasion put the test through in a couple of days, and the results were fairly comparable with tests made over a longer period. If, however, the rubber is not dry it could not be done in two days. It is not possible to hasten the drying and get uniform results. In the case of viscosity tests you have to wash and dry the rubber, so that part of the process would be the same in both cases. In the second place it takes some time to prepare a solution which is sufficiently uniform. I do not think I need say anything further as to the papers. We used a well-known type only, paper prepared by Wiggin's, Feape & Co., and described as extra strong, and it gave uniform results. With regard

to the load applied, 200 grammes, we do not suggest that that should be always applied, but it was suitable for the particular mixing with which we are working. (Dr. Stevens here explained on his machine the process pursued). With regard to what Dr. Schidrowitz said about the rubbers tested being low grade, I may say that they were of very high grade indeed. As to the reason why the tensile strength figures are not great, as Dr. Schidrowitz would expect, I may say it is not toughened with magnesia or anything of that sort to give greater tensile strength. If you look at the samples you will see that they are of particularly high grade. With regard to the figures, I presume Dr. Schidrowitz is referring to those obtained on the Schopper machine. There is a great difference between that machine and the one we are working with. To begin with, the size of the ring, and the way it is acted on, and so on; all these things have an influence and make a difference in the results, and also the fact that the rings do not revolve. I think Dr. Memmler showed that the breaking strain when the pulleys do not revolve are 50 per cent. or more less than when they do. In other words, the sample would break with half the load if you allow the crushing effect to take place with a non-revolving ring. That is the reason, I think, why the results are much lower. We have here soft elastic rubber which is particularly susceptible to crushing. The point is that with our machine we seem to get more regular figures.

Dr. MEMMLER: This is a better machine and shows more regular figures. It is not possible to have a material so well vulcanized that you always get the same results.

Dr. SCHIDROWITZ: I have made many hundreds of tests and the variation is not more than 5 per cent. I got higher figures than you have, up to 2,000 lbs. I do not wish to dogmatise, and I think that the variation is due to the fact that we are able to make the tests more even.

Dr. STEVENS: It is interesting to hear that Dr. Schidrowitz has had such figures. We have not come across them, and can only draw our conclusions from the published figures.* With regard to viscosity, about which there seems a difference of opinion, we have made a lot of tests by the true and "pseudo" methods, but I am afraid we have not arrived at the same conclusions. We have made other tests, and I think they are fairly representative. We get some sort of agreement, but not sufficient to enable us to arrive at anything like a satisfactory conclusion as to the quality of the rubber without making the vulcanization test, and that is where we differ as to whether it is good enough or not. As to the insoluble matter, I am quite clear it consists of some matter in suspension. The analysis of these deposits shows invariably a high percentage of nitrogen. We are of opinion that this matter that settles out is different from the rest of the solution, and is, in fact, protein matter.

Dr. SCHIDROWITZ: I do not think so.

Dr. STEVENS: We have analysed samples and obtained figures in the neighbourhood of those obtained by Spence. The solution above the deposit still contains much nitrogen. It is said that solutions which give the greatest amount of soluble matter should show the greatest viscosity.

Dr. SCHIDROWITZ: I say the reverse is the case.

Dr. STEVENS: It depends on the way the rubber is prepared from the latex. I think that is how I may put it.

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* Memmler and Schob. Report from the Royal Testing Laboratories, Berlin.

Dr. MEMMLER : I should like to ask Dr. Stevens how the load is measured on the Schwarz machine. I have not been able to make out from the description. I also notice that band-shaped strips, without enlarged ends, are employed as test-pieces. Our experience in the Testing Office has shown that strips like these with no enlargement, where they are gripped by the jaws are not suitable for the purpose. We found that with such test pieces we obtained, as a rule, too low results—sometimes as much as 70% smaller than when we used pieces with enlarged ends. We, therefore, concluded that we could not get trustworthy results working in this way.

I think also that the method of measuring and recording the stretch in case of the Schwarz machine, is not free from error. You take the total distance the jaws have travelled apart from their original position. Now, it is evident that any movement of the test-piece in the jaws during the progress of the test will be recorded as stretch. We could not prevent this movement, which is different with different test-pieces, and accordingly it is not possible to get concordant results with the machine. In my paper to-morrow evening I will describe for you our experiments on this point.

I agree with Dr. Schidrowitz that tests of this kind on vulcanized rubber are more significant than tests on raw rubber.

CHAPTER IV.

A Meeting of Planters, Chemists, Manufacturers, &c.

MEETING OF PLANTERS, CHEMISTS, MANUFACTURERS, etc.

Below is given the text of a discussion which took place at a Conference Session which had been set apart for a general meeting of planters, chemists, manufacturers, etc. There was an excellent attendance, though manufacturers were not so well represented as they should have been.

In opening the meeting the CHAIRMAN said: This afternoon's session, unlike the usual sessions of the Conference, is announced as a general meeting of manufacturers, planters and chemists. As you know there was no programme announced. Accordingly, I am going to make one or two suggestions as to topics on which we might at least begin talking. One question which is of interest both for planters and manufacturers alike is this: At present it is very difficult for planters and manufacturers to keep in touch with each other. Planters, in marketing their product, are undoubtedly more or less at the mercy of the manufacturers, or, more directly, of the brokers through whom their products pass to the manufacturers. Everyone who has undertaken to market a product intended for the use of any particular trade has had this experience. The commodity is put on the market; through the market it passes to the manufacturer, and in time, perhaps, there comes back an adverse report; but when one undertakes to dissect that report and ascertain what is the real point with which fault is found, and on the basis of which the material is judged as not right, it is very difficult to extract that information. I imagine it is much the same with plantation rubber. It goes on to the market, it passes into the hands of the manufacturer. Some seems to go well and some not; precisely why, the planter cannot ascertain. Now the question I thought of proposing is, how can the planter maintain a uniform standard of quality? Some lots offered and sold prove entirely satisfactory. As soon as that happens, the planter's one aim, the aim of every business man, should be—regardless of what he himself thinks his product ought to be—to maintain that quality. You have got to take the market as it is. If you furnish it with a commodity which it approves, it makes no difference what your own idea is about it. What you want to do is to continue to furnish that product. The question then arises, by what means can the planter manage to keep track of the quality of his rubber as it is produced, and make sure that having produced a certain quality, his subsequent product shall be exactly according to that particular standard. I am not very well informed as to what goes on on plantations—it will be well if some of those present, whose life is spent on plantations and who do know what goes on there, will tell us a little about the way that question appeals to them, and as to whether they have any methods directed toward this end, and whether they are satisfactory or not. On the other

hand, possibly the chemists may be able to make some suggestion as to some simple test which would enable the planter to keep track of quality. Such a test must be one that, for a given brand of rubber and a definite quality, will give the same result every time, and which will show any variation. If that topic does not happen to meet with approval, there are others which were suggested to me, and I will read them from the notes in my hand. It has been suggested that some questions as to the use of machinery on plantations might be of interest, that is, as to the mills that are used in crêping and so forth, as to what the proper roll surface velocity should be. Again, is it more advantageous to have direct-driven mills or belt-driven mills ? Then, another question that has been suggested is as to the amount of power required to drive the different type of washing machines. Another suggested question was as to vacuum drying. What should the temperature be ? What is the relation between the temperature and the vacuum required ? Still another—What is the reason why smoked rubber brings a higher price than unsmoked ? Now, among these questions, I think we may manage to find something on which we can at least make a start. Suppose we try the first, as to the means adopted by planters for satisfying themselves that their product is uniform.

Mr. Golledge (Ceylon) : There is really no test ; the only test we have is to keep the rubber free from tackiness. If there was a test, it would be of considerable service to us. The test applied in London appears to be not a scientific test or analysis, but purely a statement as to what is in demand, and so it is difficult for the planter to arrive at any definite results. We should be exceedingly grateful if there was a standard test which could be used in the East.

The Chairman : In the first place the proper place for a test is not in London, but on the plantation. If you are unable to judge as to the import or validity of the test made in London, you at least have the rubber you send to London. Now, if there was some simple test which you could apply to that, you would have a standard test to go upon, and if a subsequent lot of rubber of the same character came along you would be able to see if you had the same quality you had before. That is the kind of test that is desirable.

Dr. Huber : I am not properly a planter, but I have planted some trees in the Botanical Gardens at Para, and have made some experiments in the way of testing samples obtained from these trees. I think it is impossible for a planter to have an absolute test, but perhaps it is possible to have a comparative test. It would not be all you need, but it would be something. If you have had a lot of rubber which has been sold and you have kept a sample of it, then you know exactly the price it brought, and the opinion of the experts, and can see that the next lot you have possesses the same properties. Elasticity is, of course, the principal characteristic of a good rubber. I have seen it stated that it is impossible to compare two samples one with the other if the planter has no instruments, but it is possible to test them comparatively, and my method is the following : I cut two equal strips of the two different rubbers, and lay them one under the other and tie them together. They adhere perfectly ; we can then stretch them out with absolutely the same force and to the same length. If the two samples are of the same elasticity, when they come back they will lie flat, but if they are different —even if only slightly different—they will be in a curve, and the sample which is on the outer part is that which has contracted the less on

release. That is a very simple test which may be made by everyone, and which at least gives the difference between two samples. It indicates which is the stronger. I think, if it is not an ideal test it is something which would enable the planter to ascertain whether one lot was inferior to another.

Mr. Golledge: That is simply a test for the market, and gives you no idea at all as to the real quality of the rubber. If you have two strips, unless they are identically of the same thickness and they have been cured in identically the same way, it seems to me such a test would be of very little assistance to us at all. We know crépes are of various thicknesses, and the thicker the crépe, provided it is properly cured, the stronger it is. We know also if we take the same crépe and put it in water, then during the transport home the rubber will contract considerably and when it reaches here it will be considerably stronger and the resiliency will be greater. But they are exactly the same rubber, yet one will bring 2d. more in the market.

Mr. J. Ryan: There is another mechanical difficulty, and that is the extreme difficulty of getting two pieces of exactly the same in all three dimensions. It is practically impossible to do it, even in the rubber biscuit, which you can manipulate fairly easily with a pair of scissors, but if you take a large piece of block it is impossible to get equal strips that you can lay side by side. I suppose, too, they have had to be made to adhere by some rubber solution. The difficulty appears to me to be very considerable and with crépe you could not do it.

Dr. Huber: With crépe it is impossible, but not with sheet.

Mr. Potts: I think, apart from that, it has been shown, if my memory serves me right, by Beadle and Stevens, and Schidrowitz, that mechanical tests of unvulcanised rubber are not sufficient. Apart from a viscosity test, which this is hardly the time to discuss, there is only the alternative of making a small mix with sulphur and it would be easy to make it. There would be a difficulty in getting it smooth, but the rubber could be cut by a razor under water and you would get pieces of the same size. In that way you could get some idea. But, of course, two different samples of rubber might cure at different rates, and then the test would be defeated. Several other tests might be made. But the position that should be taken up is a more fundamental one. There is no use in producing a small quantity of high-grade rubber, because what a manufacturer wants is something on the quality of which he can rely, and from six months to six months be able to repeat. Personally, I should prefer to get 1d. a lb. less in price if I could get it always the same. The problem for the planter is not so much to raise quality, as to make from the beginning careful tests of his latex. What he coagulates should be kept absolutely uniform, and he should observe strict uniformity in his method of coagulation. I know it offers difficulties, but there is a much more hopeful outlook in that direction. I think a lot of the trouble really arises from the broker. Some time ago I worked with a little lot of rubber—about a ton—which I had not handled before. I had to use a certain amount of it to make tests and find out the correct cure. But I could not find out where it came from. The broker had carefully concealed all evidence of this, but he happened to leave a card about with the name of an island, and so by internal evidence we came to the conclusion that it came from a certain part of Sumatra. One ought to know where the stuff is coming from, so that one can guarantee getting the same again. At present you cannot be certain of it.

The CHAIRMAN: That is precisely the point on which this discussion was opened. It was not with the idea at all of distinguishing various qualities, and it was not with the idea that the same test could be used with any two different qualities. The idea was just exactly that which you have mentioned. It is true—and it is true in other places also—that the manufacturer cares a great deal more about getting something of a uniform nature on which he can rely, than he does for a comparatively small difference of quality. The thing of importance is that some method should be devised by which, having got a certain quality, no matter whether good, bad, or indifferent, the planter can reproduce it and know he is reproducing it.

Mr. FRANCIS MARTIN: I should like to address a few words to the planters from the point of view of a manufacturing chemist, and, since plantation rubber has come to stay, I think it is very important indeed that the manufacturer should come into contact with the planters in so far as the condition of the crude rubber is concerned. A manufacturer when he buys wild rubber knows that whatever kind he buys he has to wash it, and he is, therefore, entirely responsible himself for the cleanness of the washed rubber, as well as for its dryness. If then, he starts with a known grade of rubber, he can reasonably expect certain results. Now, I have bought considerable quantities of plantation rubber, and I have tested very many samples, and the point is this: on the face of it the rubber planter's idea should be to send plantation rubber into the market in such condition that the manufacturer can get out of washing and drying. If planters would do that, it would be useful. Then, if planters would always send rubber free from traces of the coagulating medium and entirely dry, the manufacturer, when he bought it, would know he had no need to wash it, and no need to dry it. You will forgive me, perhaps, if I speak as though I was addressing myself to novices, but I should like to impress on planters the necessity of eliminating every trace of the coagulating medium, no matter what it is, whether an acid, an alkali, or whatever it may be, because traces of the coagulant affect the vulcanisation by the manufacturer. The same thing applies to moisture. A small percentage will be enough to upset the manufacturer in all his operations, for he has bought the rubber with the idea that he can use it as it is. I am not suggesting chemical tests to the planters. Elaborate tests would be impossible unless they were equipped with a sufficient laboratory. I would suggest, as something to be discussed, an idea like this: Let the planter test the rubber in the early stages and not wait until it is in block form, because it is then difficult to know what there is in the interior. What I would suggest is that at some period in your operations, either immediately after you have crêped it, or as soon as you have got it sufficiently clean to crêpe it, you should apply, say, a litmus test; or cut up some of your rubber and boil it in distilled water, taking the sample in such a way that it represents fairly what you are dealing with. After cutting it up, put it in a flask and boil it with distilled water, then concentrate it and test it with blue and red litmus. Then, of course, another point is to satisfy yourself that you have your rubber perfectly dry, either by the vacuum process or any other process. That is not an easy matter for the planter for the simple reason that if you heat your rubber to the usual temperature without a vacuum and obtain your loss of weight as representing moisture you will mislead yourself, because some volatile substances other than water would be evolved. But it would be valuable

if a set of rough tests could be got together which planters could use. I think it would be possible for such a Conference as this to frame a rough set of tests which could be agreed upon by chemists and which the planters could apply as a means of bringing their product to a standard quality. I am quite certain that some such stage must be arrived at. It is a very serious thing if a manufacturer buys a quantity of plantation rubber and takes it for granted he can start right away with his manufacture, and then finds there are traces of acetic acid or alum, or that there is moisture present. Although they may be only traces it means a great deal to the manufacturer.

Dr. Esch: I wish to point out a method which is easy, and gives satisfactory results for the planter. In the case of crépe if you take pieces of crépe of the same thickness and put them in a bath of melted sulphur, and heat them, you can test the pieces, after being vulcanised, in a small testing apparatus like a spring balance which would be quite enough for experimental testing.

Professor Carmody: This is a question to which I have given attention for some time, because fortunately in the Colony of Trinidad and Tobago we are just beginning to export rubber, and have had the opportunity of studying what has been done in other countries. One of the things I have advocated has been the standardisation of the methods of manufacture. I do not think any planter can perform any analytical tests which would be of any use to the manufacturer. What we want is, and what appears to me to be absolutely necessary is, to adopt certain methods of manufacture by which the quality of the rubber turned out from any particular plantation will be uniform. Amongst the methods I have studied is the preparation of rubber by a centrifugal machine invented by Mr. Smith, of Tobago; and the excellent quality of rubber turned out has made me think a great deal of the necessity of using some instrument like that, which is simple in construction, which gives uniform results, and which gives the planter large quantities of rubber. The machine is purely mechanical in its action and it is not necessary to use coagulants. I am speaking now of *Castilloa*, which is more difficult to prepare than *Hevea*. It is quite possible to produce a rubber free from acid, even if there was a little in it originally, because it can be washed out. If you do use an acid it is quite possible to wash every trace out of it, while it is on the screen, as can be shown by a test with litmus paper. Next, as regards percentage of water, if it is necessary to produce rubber with only 2 per cent. of water, it is quite easy to do it, or with even less. As regards the resins in *Castilloa* rubber, this is a matter of importance. The variation of resins in *Castilloa* is very considerable, and it will be very necessary for the purchaser to have some indication of the amount of resin in the rubber. I think the Department of Agriculture could assist the planter by taking samples and ascertaining the amount of resin contents. It is not a difficult operation, but it is one the planter could not be expected to do for himself. The one difficulty that the planter experiences is to know the defects that manufacturers notice in the rubbers. If manufacturers would indicate these defects, the planter would be able to prepare the rubber according to their standard. I know for a fact that when samples of *Castilloa* rubber, which have been prepared under the same conditions in the same factories, have been sent to the London market, one set has brought about 7s. per lb., at a time when Para rubber was about 8s. 5d., and the second set, prepared in the same way, did

not bring more than 4s. 6d. I know it is difficult to sell *Castilloa* rubber, because they are only sample lots. Our information is that *Castilloa* is not as well understood here as in New York, where better prices are obtained. I suppose it is the conservatism of the British Colonial that makes him content to send it to the London market and get a lower price, but we should very much like to get into touch with the merchants and get their opinion as to what they require. I had the opportunity of meeting the managing director of one of the large manufacturing rubber companies a little while ago, before I left Trinidad. I showed him some samples, and he said, "I never understood that *Castilloa* was like this; I always understood it was a resinous kind of rubber. It is quite a revelation to me." One of the London representatives of a broker's firm has been down examining the samples of rubber prepared by Mr. Smith's machine from Mexican *Castilloa*, and he told me that this rubber prepared by this centrifugal machine cannot be distinguished in the ordinary way from Para—that it is as good, and would fetch the same price, and further, that if a person were not told the difference he would probably think it was Para. There are simple methods by which Para is distinguished, but he spoke in a general way, and said the quality was such that it would be judged by a broker to be the same. I shall be glad if purchasers on this side would help us by giving us any indications they can as to the kind of rubber they want.

The CHAIRMAN: I think that takes us a little from the point. No manufacturing process—it makes no matter what it is—can be relied upon to give continuously the same results unless subjected to a constant series of checks. The only way the manufacturer can produce a uniform product is by constantly checking his product. That is the point of this discussion. There are plenty of processes by which plantation rubber is proved to be good. The great difficulty is—it has been stated not only by myself, but by planters, and we may take it as a fundamental axiom—the great difficulty is to get uniformity. How is it possible for planters, in developing their methods and turning out rubber, so to check their product as to be able to tell whether it is uniform or not? There is a great deal to be said in favour of what has been proposed, but consider what a slow process it is, and how long it would take to accomplish anything. On the other hand, there are constant indications of lack of uniformity and bad quality of certain lots. What you want is some means of knowing for yourselves, whether the methods you are using produce uniform results.

Mr. HARVEY (South Mexico): I think it is asking a good deal of planters to determine what brokers or manufacturers want. The average planter is confronted with an enormous number of competitive machines, each of which claims to produce better results than the others. Boards of directors are more or less influenced in sending out this or that machine. I am a *Castilloa* planter, and it is quite as much concern to us to know what is the best form in which to get our *Castilloa* into the market. I am a bit of a free lance; I do not represent any interests. I think this is a remarkable exhibition and I notice that there are an immense number of forms in which *Hevea* is sent to the London markets from the Malay States, from Ceylon and other countries. How can planters know which is the best form since these machines are sent to them? Personally, it would appear to me that the resilience test applied to rubber does not present the ordinary test of resiliency to the same degree as with the sheet rubber which has not been manufactured

through a machine. It was remarked during a discussion on one of the papers this morning that the true test was after vulcanisation, and that the rubber which might not appear nearly so attractive on the practical test turned out, after vulcanisation, to be very much better. One cannot help being impressed with the beautiful appearance of the manufactured products and with the exhibits from Ceylon, and yet one turns to the great blocks shown from the Upper Amazon, and we are told that that is the standard and that viscosity is the standard of quality. It seems to me that manufacturers should themselves decide, or agree, on what is the best form, and do away with all other forms. How can the planter arrive at that conclusion unless he knows all about the machinery? One other point is that different trees give more or less resinous rubbers at different ages, tending toward a less percentage or resin as the trees attain age, so that a standard entails consideration of the amount of resin in any particular species of rubber trees with which we have to deal. We cannot expect the same percentage or resin at four years as at eight or ten, and I am sure that all the superiority of "up-river fine" is owing to the small percentage or resin which exists in the latex, and perhaps some of the fault found is due to the early age at which the trees have been tapped. The analysis test does show a percentage of resin much higher than in the later latices.

Dr. STEVENS: This question that has been generally discussed—I unfortunately did not hear the first part—is one that has kept myself and my colleague, Mr. Claydon Beadle, employed for the past five or six years, but I am not going to say very much now, as the result of our experience over that period, and of our work on behalf of a very large number of plantation companies, has led us to a conclusion which I can confidently state, that no planter can make a test of the relative quality of his rubber on the plantation. It is a matter which requires the greatest skill, patience and care, and unless a plantation company is prepared to spend a great deal of money in setting up a laboratory it cannot be done. The only way is to send the rubber home for testing. As to the question of uniformity, that is in the hands of planters themselves. Uniformity can be obtained simply by keeping to the same conditions all the way through, from the collection of the latex to the boxing of the rubber. And as regards investigation, the Rubber Growers' Association have a fund by which companies are enabled to obtain scientific and technical advice on these matters, and the best thing they can do is to contribute to this fund, become parties to this arrangement, and the necessary scientific advice and testing of rubbers will be at their disposal.

Dr. FRANK: So far as I have been able to follow the remarks, I gather that the subject of a standard quality and the means of fixing and maintaining such a standard is being discussed. According to my fairly extensive experience it is impossible to furnish any general solution for this problem because the quality of a rubber does not wholly depend on tangible external characteristics but on the local conditions. The questions of soil and climatic conditions are of far greater importance than the mode of preparing and handling the rubber later on. It is therefore essential that before we undertake to set a standard based on external appearance we study carefully all these local conditions—such as soil, rainfall, altitude and general climatic conditions. We cannot and must not expect to produce in every case the best commercial product: we can only produce as good a one as circumstances will per-

mit. Furthermore, we must try to give the planter a simple and reliable method of controlling his crops. We are not dealing with absolute values; they are all relative but they are quite definite enough if we unite on them and if planters will only realize the importance of this matter of uniformity. We hope we have in the viscosity determination a means of controlling and checking quality, but we must wait for the Meeting of the International Testing Committee to-morrow to see how results by different experimenters compare. It is not necessary nor is it desired by any manufacturer that there be only one standard quality of raw rubber. What he does desire is workable, uniform, individual sorts—which may differ greatly among themselves both in characteristics and in method of working. The plantations can meet this requirement, and they should do their utmost to meet it speedily.

Mr. WHALLEY: I understand from the catalogue that the total value of imports of rubber last year into this country was 26 millions sterling, and I presume the object of this Conference is to determine the thing that can be done rather than the thing that cannot be done. The mechanical engineering trades have met together and formed the Engineering Standards Committee, and they have produced standard specifications accepted throughout the empire. Surely it is possible that an industry with an export equal to 26 millions sterling can also produce standard specifications which will give a sample a plain definition as to what constitutes the best quality of rubber, whether hard Para, white, or soft brown; what constitutes a medium quality, and what constitutes any other quality. These sample specifications to indicate: Take the case of dirt, whether they are to be free from dirt—that means absolutely none at all—or to have half or one per cent.; also in the case of the absence of traces of coagulants, if it means none at all, or a small percentage or trace; also if there is a varying percentage of resin to state what the limit is; also if a particular quality of rubber contents is demanded in the way of viscosity, or nerve, or whatever it is, to give a plain and simple definition. Once you have attained simple standard like that—and at first it may not be correct—then the planters, or the chemists employed by them, can see if it is possible to produce simple tests—not laboratory tests which require a skilled chemist to carry out at a cost of £1,000 to £2,000 in equipment, and a skilled engineer to carry them out at a salary of £500 a year—but simple tests which the average man of average intelligence can carry out and get results between 1 per cent. and 2 per cent. It seems to me that should be the first start, to let us know what it is you aim at in regard to the grade of the rubber and its quality. The planter has not the troublesome problems you have in England with regard to the investigation of rubber, where you have millions of cases of rubber which have to be tested, coming from hundreds of estates. The planters' problem is quite simple compared with this, in that he always has the same trees, and the same kind of rubber, with only a variation of moisture and temperature. It seems to me you cannot produce a standard test for planters until you agree to a standard of quality for each class and a classification of rubber.

Mr. GOLLEDGE: In that case the rubber should be sold on a test. It would not be sufficient for a broker to handle the rubber, or decide as to its quality by feel and sight. It would have to be a test, or otherwise nothing would be gained. One gentleman remarked on centrifugal coagulation. I understood, until he spoke, that no scheme had been evolved for coagulating *Hevea* latex by centrifugal action. Hitherto it has been tried and found wanting, but, I believe, as far as *Castilloa* is concerned, it is successful.

Mr. Potts: There is some misapprehension as to the qualities which determine value. Dr. Stevens will bear me out that even hard Para contains more acid in some cases than good quality plantation rubber. Consequently, the test for traces of coagulants falls to the ground. Then fine hard Para often contains more resin than the best quality of plantation rubber, and I think I may say, speaking generally, that it is immaterial to the manufacturer what the percentage of resin is within a percentage of 1 per cent. or 2 per cent. The main point we want to determine is what the molecular texture of the rubber is, and none of the tests proposed, except viscosity, touch the fringe of the subject.

Mr. Martin: In view of the fact that plantation rubber ought to be usable just as received in the factory, I fail to see why the absence or presence of traces of coagulating material are unworthy of notice. As far as my experience goes the presence of any kind of acid, if you are using your rubber for electrical installations, is a serious matter.

Dr. Frank: It appears to me that too much stress is laid on the resin determination. According to our experience in testing plantation rubber the percentage of resin (provided it lies within the right limits for that particular rubber) may or may not be significant according to the *nature of the resin*. We have to distinguish between hard and soft resins. The former are generally the more objectionable from a technical point of view—and it is worthy of note that the nature of the resin seems to be determined largely by the soil—as shown by many comparative tests which have shown that the same rubber grown under different circumstances shows decided variations in its resin according to the local conditions. The nature of the resin is also something of a factor in the viscosity determination.

Mr. Ryan: I would like to ask whether the author knows any broker who has applied tests. It is useless for us to apply tests at our end which will not be applied at the other. I have watched many tests, but they were hardly what you would call scientific. They were mostly rule of thumb. What was most frequently done was to sort samples of rubber so as to get fairly even lots for the manufacturer. I should like to know if chemical tests are applied in the broker's office.

Mr. Martin: I have no knowledge of brokers applying such tests. I should like to make it clear that my remarks were based on the supposition that plantation rubber is to be used without practically any tests. In that case, traces of acid, which might be held of no great importance for mechanical rubber, would be of vital importance to the manufacturer of rubber for electrical installations. My ideal would be to get planters to organise to deliver under guarantee their material to the market so that the manufacturers could take the rubber and use it practically without any test.

Professor Carmody: In answer to the gentleman on my left, who said the centrifugal machine was not successful with *Hevea*, I may say that Mr. Smith's machine is quite successful, but in the treatment of *Hevea* latex it is necessary, in order to get rapid and satisfactory results, to use a small quantity of acetic acid especially to bring about granulation. The rubber then comes out in 4 or 5 minutes. I would mention, in connection with what was said by a gentleman opposite, that the

percentage of resins in *Hevea* prepared by this machine may be regarded as constant. I agree that it is desirable planters should produce a rubber of standard quality, and that buyers on this side should be only required to check them from time to time to see that they are reasonable samples.

Mr. HARVEY (South Mexico): Though operating beyond the dominion of the British flag, I must inform you that there is a great deal of British capital invested in other countries, and I beg to ask permission for a little consideration on that score. Throughout Spanish America we are interested mainly in *Castilloa*, though we have some creditable *Hevea* plantations, even in Mexico. The general custom is to use the juice of a vine belonging to the *Convolvulus* species, and it seems to me there is sufficient importance attaching to it to lead British chemists to investigate the qualities of that vine to see if some manufactured form of that juice might be made with a view to its use instead of acetic acid. At present, as we use it, it only keeps a short time, but it is possible a preparation might be made so that it could be used in other countries. It seems to us, as practical men, that there is a certain strength added to our *Castilloa* rubber by the use of it. We first eliminate impurities by the use of water, and then we eliminate what we popularly call the "Mother liquor," the serum, which has the effect of causing *Castilloa* to turn black. We have found a way of eliminating that discolouration by absolutely excluding the influence of the atmosphere during the process, and the result is we are able to turn out the *Castilloa* rubber of a pale amber colour.

Mr. MARTIN: In more or less substantiation of a previous speaker it occurs to me that the question whether planters shall test for themselves or not is in their own hands. If they get together and employ the right men there is no reason why the desideratum of preparing a reliable quality, and a definite quality, should not be attained. As to saying it is impossible for the planter to do it, it is impossible under present conditions, and unless they can find men who can handle the matter efficiently. If we can test rubber on this side, why cannot you do it there? If you test the plantation rubber you are in a position to cut out entirely the small points which create difficulties when the rubber is brought over here.

Mr. CLAYTON BEADLE: The analogy of steel having a standard test is not a fair one as applied to rubber, because in steel you have certain other elements which have a very pronounced physical effect upon the product. In the case of rubber you have accidental impurities. Whether they are beneficial or not it is difficult for us to say, or to what extent they are beneficial, but if you set up an arbitrary standard in regard to the various constituents, as at present determined by ordinary chemical analysis, and grade the rubber on that basis, you would set up a fictitious standard because the purest rubber is not always the best. The presence of the impurities is something apart from the rubber itself. If you grade the rubber I think we should be setting up a fictitious standard. All the rubber planter would do would be to seek to comply with that standard, and he would have no incentive to modify the rubber to the special requirements of manufacturers which are not capable of being determined by standards of this description.

Dr. PETCH: I think there is some impression that planters could send a product which would not have to be washed and dried at this end. No doubt he could do it with extra washing and drying, but he would

want some compensation for the extra work. If you are estimating that the planter will send you a rubber that will not have to be washed and dried, you are working on a wrong assumption. There is a point as regards uniformity which does not seem to have been touched on. In the case of *Hevea* rubber from eight-year-old trees, it is not as strong as rubber from twenty-year-old trees. We have published figures which show this fact. If you are going to standardise quality you would have to state the age of the trees, as well as the amount of moisture, and so on.

The CHAIRMAN: I dislike to say anything with reference to Dr. Stevens' remarks, because he is not here to talk back, but I am sure he will forgive me. I merely want to say to the planters that I am sure you will agree with me that the statement that any manufacturing process, or any routine process on a large scale, can be relied upon to produce a uniform product by simply, as he says, observing the same conditions throughout, will never work out in the world. We have everywhere manufacturing processes going on where material is being produced by tons and tons; we have trained men whom we have had for years in the same business at every point; trained men who are watching every detail in the most scrupulous manner, and yet we go wrong sometimes. The only thing that saves us is that we have evolved methods by which we know we are going wrong, and we can stop it. You will not make any progress in producing uniform rubber until you take the thing in your own hands. The second point is as to the possibility of there being such a test. What I think of that is involved in what I have said about the other. I do not think it pays to take a hopeless view of the matter at all. I think you *can* do something, and I think moreover you are the very best ones to work it out. You can work it out; you can find some simple way; it is more a question of pinning your attention to that one thing, of studying it on your own ground and by your own means, and if you do that thoroughly you will succeed. What is wanted is uniform rubber more than anything else. You will find that you produce a uniform rubber when you follow out the course suggested. The manufacturer does not care whether there is 3 per cent. or 6 per cent. of resin in the rubber. Resin, from the manufacturer's point of view is a small point. If you want to find out from the manufacturer why he considers one rubber better than another, he will not tell you because it is extremely hard work to do so. He only knows that when he gets that rubber into use it produces good results. The place where he comes to grips with it, and where he draws his first accurate conclusion, is where he vulcanises it, and the vulcanisation test is not by any manner of means out of court even on plantations. A simple little mixing mill, and perhaps a calender for calendering sheets, and a little vulcanising press that will enable you to make little vulcanising tests, could be laid down for something like £250. What is that? Applying a simple uniform vulcanising test to the same grade of rubber is a thing an ordinary lad can be trained to do in a satisfactory way. So I say to you do not take any hopeless view of the matter. You can help yourselves.

Mr. GOLLEDGE: We are with you, but would ask you to sell by test at home, if we are to do the work by test. It is no use our testing our rubber if it is not to be sold on the test at this end, but purely by sight and feel.

The CHAIRMAN: Still, you will agree that it does not matter whether the rubber is sold by feel, if you send out rubber which can be depended upon.

Mr. GOLLEDGE: Feel is not everything.

The CHAIRMAN: If you send it always the same the feel will be always the same. The problem is to get uniformity, and lack of uniformity in plantation rubber is the growing evil of the whole planting industry. I will guarantee that if you solve that one problem, and learn to produce *any* grade you please of rubber, that is the same from lot to lot, nine-tenths of your difficulties will vanish.

CHAPTER V.—SECTION I.

(I.) FRITZ FRANK.—"India-Rubber Research."

(II.) WILLY HINRICHSEN.—"Theory of Vulcanisation."

(III.) J. JAQUES.—"The Adaptation of Different Raw Rubbers for Manufacturing Purposes."

(IV.) FRITZ FRANK.—"The Technical Use of Plantation Rubber and the Conditions which, in the Production of Raw Rubber, are of Importance for its Technical Application, with Special Reference to *Kickxia* (*Funtumia*) and *Manihot* Rubber."

(V.) C. CHENÉVEAN and F. HEIM.—"The Extensibility of Vulcanized Rubber."

(VI.) H. E. POTTS.—"The Oxidation of Sulphur by Nitric Acid."

(VII.) CLAYTON BEADLE and HENRY P. STEVENS.—"Impact Tensile Tests on Rubber and a Comparison with Tensile and Hysteresis Tests."

(VIII.) K. MEMMLER.—"Mechanical Tests for Rubber."

India Rubber Research.

By DR. FRITZ FRANK, Berlin.

During the years that have elapsed since the last Exhibition, an extraordinary amount has been accomplished in rubber research. Many pieces of work which at that time were only in the initial or experimental stage have since, as the result of further work, received definite support, while others have lost the support they then had and must be given up. Others, again, are still in process of development.

On the occasion of the last exhibition, Dr. Marckwald and I were able to make a communication which in a measure ran counter to the spirit of the period. The general aim at that time was to extract the rubber from a mixing directly by means of its capacity for reacting chemically with other substances, *i.e.*, to separate it in form of one of its derivatives, and in this form to weigh it. We, however, saw the great value of our process, as compared with the older methods, in that we endeavoured to fix more precisely the quantities of the organic and inorganic ingredients, and to characterise them according to their nature. This process, which we had already at that time tested and employed for years, has developed in the meantime to such an extraordinary degree that we can only regret that we are to-day not yet in a position to communicate positive results to the effect that the determination of the rubber substance as such has been successfully accomplished by a similar method of working. The reason for this is that all methods which involve direct weighing of the rubber substance in form of one of its derivates are still unreliable in spite of the very great number and variety of investigations bearing on this subject.

As is well known, Weber was the first to attempt the determination of the rubber in rubber goods by weighing it as a derivative. Later on, his method was found to be faulty. Harries and Alexander followed in the same direction and through the labours of these investigators we have obtained an explanation in the analytical sense, which though not absolutely free from objection must still be considered as a valuable aid. Axelrod, Feudler, Budde and Hübner worked on other lines in that they converted the rubber into a halogen addition product and weighed it in this form. Sources of error were, however, soon indicated by numerous investigations, some by the same investigators and others by Harries, Spence, Gottlieb, Korneck and others ; but the real source of these errors was not made entirely clear. All these researches were concerned with the valuation of raw rubbers by the " bromide process."

Hinrichsen has worked differently with Axelrod's method, which endeavours to determine the rubber substance present in mixings. He thinks he sees an objection to the process in the fact that some filling materials form bromides, and of these, bromide of lead especially, is volatile and, therefore, a source of error in determination, in that it increases the apparent amount of the rubber substance.

Axelrod has already met these objections and has shown how this fault may be considerably diminished in practice. I can but agree with

Axelrod in these statements. Generally the process works very well for technical research, though, of course, such a method cannot be brought into comparison with the methods of mineral analysis. Just as Axelrod improved and proposed his bromide process for technical rubber mixings, so has Alexander, following up Harries' proposals, employed the nitrosite process for the same purpose. He has also given data and factors suitable for technical purposes. In particular he has shown that the process can also be used for reclaimed rubber as well as for mixings which contain none of this material—so, even though the nitrosite process has not come into general use owing to experimental difficulties and other uncertainties it still serves, in some factories, to determine directly, with tolerable certainty, the "combined sulphur," because in the nitrosite of soft rubber all sulphur which is combined with rubber apparently holds its place and the nitrosite can be separated quantitively from substances unaffected by nitrous acid and from the mineral matter by means of solvents.

Errors of 3% or even 4% in either direction cannot be avoided when using such processes for analysing technical mixings; they have to be reckoned with if such processes are employed; moreover a reliable and unobjectionable formula for the nitrosites is still lacking. With the same mixings values are obtained, by the bromide process, which are often unobjectionable and which agree with each other within 1 per cent.; but the method requires an expert hand.

Hübner has shown that even in complicated mixings and in hard-rubber the determining of sulphur as well as of rubber can be executed directly through calculation, by the bromide process, but even though the determination as bromide by Axelrod's method is often possible, the formation of the derivate form rubber that has been subjected to long continued heating offers unexplained difficulties. The same thing is encountered in nitrositing. The bodies obtained under these circumstances differ materially from the known derivates in composition, and the reactions are of such complexity that so far no uniform weighable substance has been obtainable. This is another reason why we have not yet been able to build upon the before-mentioned process for the indirect determination of rubber and the direct determining of mineral-filling bodies—as we had hoped to do—to a direct method of determining the rubber substance.

When we published our xylol process we pointed out that other high boiling solvents as well cause breaking down of the rubber molecule on boiling, to such an extent that on appropriate dilution filterable solutions are obtainable. Hinrichsen and his co-workers have attempted to use a simple process. He proceeded in the following manner: he used as a solvent petroleum—as formerly recommended by Henriques and later by Axelrod—using, however, only that part of the petroleum boiling at the temperatures we use. His mode of working was very tempting, for it unquestionably meant a very welcome simplification of the process. Unfortunately, however, this simplification could not be generally employed, for it was found that the disintegration of the rubber molecules, and seemingly also of the accompanying albumenoids, etc., does not always go on smoothly. Moreover, the filtration of the solutions obtained is difficult and not quite reliable. The proof of this fact has been furnished experimentally by myself and my co-workers by a large number of experiments, and I must say that I did not enjoy making these experiments, for every simplification of the already complicated analytical method of working would have been hailed

with joy. Hinrichsen and his co-workers have, then, instead of petroleum used other substances, namely, those which the Bale Chemical Works manufacture under German patent No. 202850 for the reclaiming of rubber. These substances have not shown themselves unexceptionable for reclaiming purposes and have not been of as much service as solvents for rubber analysis as would have been desirable. It must, therefore, be stated that to-day in making indirect determinations of rubber only the original process with xylol or a benzol hydro-carbon of appropriate boiling point is reliable. A determining of the rubber substance by precipitating it from its solution in high boiling solvents at high temperatures is not reliable for the simple reason that the disintegration of the rubber is too far advanced. The rubber substance *as such* is no longer precipitated. It is true that Seidl has shown that by appropriate manipulation it is possible to obtain quantitively the rubber as such, though in sticky form; but the method of making a technical analysis as indicated by this investigator is somewhat complicated and requires the employment of large quantities of material. Nevertheless, through this beautiful piece of work, additional proof has been furnished of the correctness of our own indirect method. On the other hand attempts have been made to modify and improve the process by disintegrating and separating the substance in solution through the agency of alkali. Such a process misses its aim because the broken-down rubber molcules give decomposition products, which, as is well known, show different behaviours with alcoholic potash. If, nevertheless, one wishes to follow this procedure, very special and tedious preliminary preparations are necessary.

Therefore, as to analytical methods for technical rubber mixings, we have practically arrived at a deadlock, though much must be accomplished by further intensified research. It is very desirable that there be through co-operation on the part of all interested and that as much analytical data as possible be brought forward. If literature is filled with isolated ideas it only confuses and profits nothing.

The testing of raw rubber has been held back by the before-mentioned difficulties in determining rubber in form of one of its derivatives and has reverted to the original stage, i.e., indirect determinations. We might hail this seeming retrogression as progress, so far as it concerns the uniform valuation of raw rubber. The conclusions of Spence and Jacobsen, which depend in some measure upon older teachings by Obach and Tromp de Haas, and in some measure on our method of testing gutta-percha, have caused this change. On this side experience in raw-rubber points in the same direction and indicates that if it is intended to free the latter from foreign bodies by filtration, the rubber molecule must be broken down by means of high-boiling solvent since by this means solutions are obtained which can be filtered through filter-paper.

Fendler has already put forward very valuable proposals in this direction. He uses toluol as a solvent. In our work, however—which we have not yet published—we have adopted the use of still higher boiling liquids, such as xylol, or petrol benzine fraction of the same boiling point, or even cymol or a petrol benzine fraction of corresponding boiling point. If raw rubber is boiled in such solvents in such a way that it is gradually added to the solvent and afterwards kept at the boiling point until a uniformly thin solution is obtained, a liquid of the thinness of water is obtained from which it is possible to separate quantitatively—either by filtration, or better still, by "centrifuging"—the

mineral constituents and the albuminoids. We have, therefore, following Spence's proposal, and also in the light of further experiments of our own, adopted the centrifuging method in the examination of technical rubber goods. Hinrichsen and his co-workers have also recommended centrifuging and have employed it in their work. For this purpose we have had a special centrifugal-machine constructed with which we can attain a regulated rate of rotation varying from 1,000 to 5,000 per minute. For the analysis of technical rubber goods, it is found that a rotative speed from 2,000 to 3,000 gives a quantitive separation of the mineral constituents from the rubber substance, provided the solution be stirred up two or three times with fresh quantities of solvent which has gone into solution. For raw rubber, however, a rotative speed of from 4,000 to 5,000 per minute is necessary and the centrifugal must repeatedly be run for half-an-hour after each stirring, in order to obtain trustworthy results. By this procedure the separation of the albuminoids can also be effected with fair accuracy. *En passant* it can be proved beyond reasonable doubt that the old method of calculating the albuminoids is not reliable. It will be remembered that the practice was to multiply a quantity of nitrogen by 6·25, this figure being based on the average percentage of nitrogen in proteids. We have set ourselves to examine more minutely the albuminoids thus obtained, but fortunately we have been too busy to carry these tests through to the desired end.

Still, we anticipate results from these tests in the way of clearing up the whole subject of albuminoids.

Another important point may be mentioned—the determination of the resin in rubber goods and mixings. I think it is absolutely erroneous to regard as "resin" that part of the mixing which is soluble in acetone, and which is not sulphur or paraffin. The experienced technologist knows how to make acetone-soluble resin insoluble; on the other hand it may happen even to a most experienced manufacturer, that through a slight error in manipulation, good rubber substance becomes soluble.

The work of Marcusson and Hinrichsen, as to the interpretation of resin results, is interesting. It is only to be regretted that these investigators have not yet found how to make possible the classification of rubbers on the basis of the resin. I am inclined to think that besides accidental contaminations it is desirable to follow the hints given by van Romburg a long time ago. He proved the presence of cholesterine and cinnamic acid in gutta-resin.

There has been more progress in the mechanical testing of rubber than there has in its chemical examination, and it is very gratifying that representatives of all nations have taken part in this very important work. The French investigators have accomplished much good and valuable work, since Heinzerling and Pahl, about 20 years ago, first gave the impulse in this direction. The apparatus in use until about 1907 was unfortunately not very reliable and it was a matter of great satisfaction, therefore, when Breuil, Delaloë and other experienced craftsmen and scientists set themselves to construct suitable apparatus. In Germany for a long time the tests were made in many different ways. Latterly, for the most part, paper testing machines have been used. The most varied forms were given to the test pieces, and it was found that however it was done only accidentally agreeing results could be obtained.

Schopper who, following our suggestion, had for many years worked on this problem, at last succeeded in overcoming all difficulties that had been encountered. Subsequently, acting on a proposal made by Professor Dalen, at the last exhibition I made a thorough report on this testing

process. The usefulness of the machine has been confirmed by the thorough work by Schidrowitz, and later, by the very detailed studies of Memmler and Schob at the Königl Material-Prüfings Amt.

I am, therefore, glad to say that the statements which I made at that time based on my own experiment may to-day be considered as thoroughly confirmed. Among other mechanical testing processes only the important one designed by Schwarz (hysteresis machine) will be mentioned. Important technical results will also be given by the apparatus by Martens. Finally, we suggest that the mechanical tests on vulcanised rubber be supplemented by a viscosity test on the raw rubber which will give a further means of valuation. As far as experiments have gone, we can state that this new method of valuation (used first by Axelrod and later by Schidrowitz and others) promises to prove generally reliable for the valuation of raw rubber. It is true the figures obtained are not generally comparable. The different rubbers vary according to the kind as well as to their origin.

In the interest of the correct valuation of raw rubbers, I should be glad to see a large mass of experimental material brought together. This would be a step towards freeing us from arbitrary commercial valuations and would also enable the planter to obtain a control over his products, placing him in a position to offer to the user a product of a guaranteed value. I know very well that the proposals I have made in this direction have not met with general approval ; but I believe objectors will change their minds when they have taken the trouble to test a number of comparatively uniform rubbers in the way I have proposed. After all, in 1908, when I made my first report regarding the tests made with Schoppers apparatus, a similar, perhaps even a still stronger opposition to the use of the apparatus was encountered. To-day there are only a few voices raised against the great availability of the apparatus, especially for technical purposes. In closing my remarks, I may say that I realise that they are far from complete. I might repeat that I do not at all uphold a narrow way of viewing investigations and proposals of a general character. On the other hand, my endeavour is always to carry through an investigation with the best means available when once it is undertaken. Only a conclusive argument, substantiated by figures, can draw me from my chosen path, and only sound arguments, backed by figures, can induce me to take up a new method of working. Of course, every proposal has to be tested as to its merits provided it is not illogical. What we all require is a well-defined uniformity of the testing process, for this is the only basis on which the rubber producer, as well as the rubber industry and the consumer of rubber goods, can safely and profitably meet.

Theory of Vulcanisation.

By Prof. Dr. WILLY HINRICHSEN.

Dr. TORREY in the chair.

The CHAIRMAN : We are to have this morning a paper to which we shall all listen with great interest ; it is by Professor Hinrichsen, on the subject of "The Theory of Vulcanisation." This is a subject on which we heard something about 10 years ago, but which came to more or less of a standstill, nothing more of importance being said until within the last two or three years, when there has been an influx of literature on the subject which has given it an entirely new shape. This paper will prove a most interesting one and give you an idea of the stage of progress which has been reached so far.

There are, at present, two proposed theories for explaining the phenomena of vulcanisation—one chemical, the other physical. The older—the chemical theory—as laid down by Weber[1], assumes that the changes that take place in vulcanisation are associated with the formation of a series of definite compounds of rubber with sulphur or protochloride of sulphur.

The newer, or physical theory, which has been advocated especially by Wo. Ostwald[2], holds that the taking up of the sulphur or protochloride of sulphur by the rubber is exclusively a surface action or *adsorption*. Experimental evidence has been offered in support of each theory. Hinrichsen and Kindscher[3] were able to show that when excess of dissolved protochloride of sulphur is added to a rubber solution, there appears after some time a precipitate which is very probably a compound having the formula $(C_{10}H_{16}) S_2 Cl_2$. On the other hand, it follows from these experiments as well as from earlier work by Hinrichsen and Meisenburg[4], that physical phenomena (adsorption) must also play a part in vulcanisation.

Bysow[5], on the other hand, proved that by immersing solid rubber in a solution of protochloride of sulphur, *i.e.*, under conditions resembling those obtaining in practice—protochloride of sulphur was taken up by the rubber in good conformity with the typical adsorption curve. These last two investigations differed as to the experimental conditions. In one, *rubber in solution* was used, in the other *solid rubber*. Another point of difference was in regard to the duration of the experiments. Bysow's experiments were completed in an hour or two ; while those by Hinrichsen and Kindscher extended over several weeks. Although, then, the results of these two investigations do not appear to be at all comparable, Wo. Ostwald[6] has sought to refer the apparent contradiction solely to the

(1) "Zeitschrift für angewandte Chemie," 1894, 112, 42.
(2) "Zeitschrift für Kollöide," *6*, 136 (1910).
(3) ib. *6*, 202 (1910).
(4) "Chemikerzeitung," 1909, 756.
(5) "Zeitschrift für Kollöide," *6*, 281 (1910) ; *7*, 160 (1910) ; *8*, 47 (1911).
(6) "Zeitschrift für Kollöide," 7, 45 (1910).

different concentrations of the protochloride of sulphur solutions. According to him, since Bysow's protochloride of sulphur solutions were very dilute, and Hinrichsen and Kindscher's very strong, the two sets of results can be plotted on a single adsorption curve so as to show the relation between protochloride of sulphur taken up and protochloride of sulphur employed. The portion of the curve rising vertically, at the outset would then correspond to Bysow's experiments and the later or horizontal portion to those of Hinrichsen and Kindscher.

Against this view of Wo. Ostwald it appears to me that the difference in the results obtained by Bysow and by Hinrichsen and Kindscher is simply a result of the different experimental conditions. From the standpoint of colloid chemistry it is self-evident that if solid rubber is immersed in a solution of protochloride of sulphur, surface adsorption takes place first of all, which is also verified by Bysow. On the other hand, the precipitate obtained by Hinrichsen and Kindscher possesses, is so fundamentally different from the original rubber that under these conditions a decided chemical change must have taken place.[1]

If vulcanisation is merely adsorption, then it is to be expected that the process will be easily reversible when carried out in any medium which is a solvent for both rubber and sulphur protochloride, for this is a universal characteristic of adsorption actions. As is well known, however, it is only possible to withdraw, by means of solvents, (acetone) part of the sulphur present, *i.e.*, the so-called " free sulphur " from the vulcanised rubber, while the remainder, or " combined sulphur " is not removable by acetone. It might easily be assumed that " free sulphur " represents the adsorbed part, and that which is insoluble in acetone; the "chemically combined " part. This latter portion is of special importance for the so-called " vulcanisation co-efficient " which is used as a measure of the degree of vulcanisation.

Since combined sulphur cannot be withdrawn by solvents, and since, on the other hand, no chemical method has been found by which the perfect de-vulcanisation of the vulcanised rubber can be effected, the majority of practical chemists have accustomed themselves to the idea that the problem of de-vulcanisation must be regarded as incapable of solution, but this idea is not justified. Every chemical reaction is reversible, and we may confidently anticipate that when a suitable catalytic agent has been found, through whose action a de-sulphurisation is possible without destroying the rubber molecule, the problem will be solved.

But the idea that vulcanisation involves adsorption as well as chemical action takes a commanding position when the *reaction velocity* is considered, for in case of adsorption, equilibrium is reached with extraordinary rapidity, as Freundlich[2], in particular, has proved ; while, on the other hand, chemical action between undissociated organic bodies proceeds very slowly.

One could, then, quite easily foretell the phenomena of vulcanisation : *at first there will be merely superficial adsorption of the vulcanising agent, and afterwards chemical union between the rubber and the adsorbed sulphur or protochloride of sulphur.* The velocity of the chemical action must largely depend upon the external experimental conditions (concentration of the sulphur or protochloride of sulphur, the pressure and, particularly the temperature). At the temperatures employed in practice for hot vulcanisation (130° or higher) the velocity of the chemical reaction between

(1) See Hinrichsen " Kunststoffe " *1*, 41 (1911).
(2) " Kapillärchemie," Leipzig, 1909.

rubber and sulphur is so great that within the time required (say one hour) notable quantities of sulphur may have gone into chemical union.

If this view is correct, it is to be expected that the second part of the reaction—the chemical fixing of the sulphur—will take place not alone at the temperatures employed in the practice of "hot vulcanisation," but at any temperature. Naturally, however, the velocity of the action will be proportionally less as the temperature is lower. One chemical result of this action would be that "free sulphur" would *in time* pass into "combined sulphur"—indeed, phenomena are already known which confirm this conclusion, *i.e.*, the so-called "after vulcanisation."

In connection with an investigation by A. Martens regarding the influence of different storage conditions upon the mechanical qualities of rubber, chemical tests were made as well, and these clearly showed that after a certain time there was a decrease in the "free sulphur" and an increase of the "combined sulphur." This is exemplified by the following figures :—

TABLE I.

Influence of the storage of rubber on the "combined sulphur" contained therein.

No. of test.	Kind of Storage.	Sulphur. Total %	Free %	Combined
1.	Delivery condition	9·0	4·5	4·5
2.	Six months at room temperature, stored dark and damp	8·9	4·3	4·6
3.	Do. dark and dry	9·0	4·1	4·9
4.	Do. in the light (on the roof)	8·4	2·3	6·1
5.	Do. at 70° dark and damp	8·5	2·0	6·5
6.	Do. dark and dry	8·6	1·1	7·5

A number of further experiments showed that at a temperature of 80–90°, an increase of the "combined" and a decrease of the "free" sulphur was plainly to be observed in a few days. This fact offers a simple means of ascertaining the influence of the different additional ingredients which are used in practice on the rapidity of vulcanisation under conditions which very nearly approach those obtaining in practice. It is only necessary to begin with unvulcanised mixings of rubber and sulphur, or rubber, sulphur and compounding materials. Let these mixings be stored at 80°, and from time to time determine, in small samples, the quantities of "combined" sulphur. A number of experiments, comprising twelve mixings, are at present under observation, as well as experiments by which the influence of pressure on the rapidity of vulcanisation are watched and quantitatively noted.

From the foregoing it follows that physico-chemical methods, and especially the laws of reaction kinetics are able to offer fruitful suggestions for a systematic and scientific investigation of vulcanisation phenomena, as well as for practice.

Dr. KUHLEMANN: I am quite of the same opinion as Dr. Hinrichsen that the effect on the rubber was due to after vulcanisation and not to oxydation, as we could not find any oxygen present; the result, therefore, could only be due to after vulcanisation.

Mr. H. E. POTTS: I might give you the results of an experiment of mine. I made an ebonite mixture in a sealed tube and found that the mixture heated one week contained 2% combined sulphur, rolled out nicely into sheets, and was not tacky as it was at first. A mixture which was kept under heat for three weeks rolled out in a fine powder which was not tacky at all and contained 15% of combined sulphur.

There has been no case mentioned in literature in which an absolutely uncured mix of sulphur and rubber has been found to vulcanise.

The CHAIRMAN : What was the temperature ?

Mr. POTTS : 100° Centigrade.

Mr. CLAYTON BEADLE : Possibly some light could be thrown on the theory of vulcanisation from the changes which rubber goods undergo after vulcanisation on their being kept. The changes which rubber goods undergo after manufacture, as the result of time, are very obscure, and it appears that although vulcanisation can only take place at some initial temperature, yet when once vulcanisation is initiated the process can go on subsequently at normal temperatures. It would be interesting if some experiments could be carried out to determine to what extent, if any, the sulphur combines with the rubber as the result of storage at ordinary temperatures.

The CHAIRMAN : The discussion of this paper seems to have taken a rather peculiar turn. I do not see exactly what is the difficulty with the idea that vulcanisation, no matter whether chemical or physical, may take place at ordinary temperatures. We have long ago become accustomed to the idea that hydrogen and oxygen, even at ordinary temperatures unquestionably react, though admittedly to an unmeasurable extent ; and the same applies in all reactions. Even if we regard the process as adsorption, the same thing must be theoretically true. The question whether the amount of vulcanisation at ordinary temperatures is detectable is a different matter, and to my mind there is little difficulty in understanding the great divergence of opinion, because the experimental difficulties are very great.

Dr. W. ESCH : Dr. Hinrichsen is of the opinion that vulcanisation of a mixture containing only rubber and sulphur, takes place even at temperature of from 17° to 30° Centigrade. He draws this conclusion from the fact that such mixtures of rubber and sulphur, initially vulcanised show, in some cases, a further vulcanisation effect when heated for a long time at 70°–80° Centigrade. The lecturer also thinks that chemical reactions which take place in a short time at higher temperatures, take place in the same way at lower temperatures, but, of course, in a longer time. He states as his opinion that the sulphur at first becomes merely adsorbed by the rubber hydrocarbon, and that afterwards a part of the adsorbed sulphur enters into chemical combination with rubber. I beg to state, that I exposed a rubber mixing of the well-known tyre repairing type—a mixing which becomes thoroughly vulcanised at 130° Centigrade in the extraordinarily short time of five minutes—for more than six months, to the sunlight, pressing it against the glass of a photographic copying apparatus, I did not perceive the least trace of vulcanisation. It is a well-known fact that some mixings for rubber footwear are cured with use of Bristols Chart, that is to say, the vulcanisation begins at 70° Centigrade ; but such mixings contain fair amounts of resin, pitch and the like materials, which cause a melting of the sulphur, and after being molten, the sulphur is able to enter into reaction with rubber. But carefully made rubber mixings with sulphur alone contain no molten sulphur. If the sulphur is not molten it can never be absorbed by the rubber hydrocarbon, and if it is not absorbed it cannot be chemically combined by the rubber hydrocarbon. It is true, that notable quantities of free sulphur evaporates from rubber goods even at ordinary temperatures, but this evaporated sulphur does not evaporate in the state of sulphur vapour, but in the state of sulphur dioxide.

Prof. Hinrichsen: I should like to offer my best thanks to all the gentlemen, especially the Chairman, who have taken such a great interest in my lecture. Coming to details, I should like to remark that the hypothesis discussed was primarily an attempt to formulate the simplest possible view as to what takes place during the vulcanisation process. Co-operation in the experimental work on this very difficult problem is essential.

Dr. W. Ostwald (communicated): I should like to call attention to two points which speak in favour of the vulcanisation process taking place at ordinary temperatures—no matter whether we regard the process as physical, chemical, or both combined. From my very earliest publications on the subject I have always regarded the latter as possible, and have not, as Prof. Hinrichsen thinks, confined myself to the *role* played by adsorption. The first point to which I allude is the fact that the vapour pressure and the melting point of any material are very notably raised or lowered when the material is in a very fine state of division—as in case of flowers of sulphur. Pawlow has found that microscopically fine dust of Salol, antipyrine, etc., melt a matter of 7^0 below the regular melting point when a less finely divided material is used. When sulphur is mixed with rubber by the rolling process it is undoubtedly in a still finer state of division, and under these circumstances these effects will be still more pronounced. Furthermore, when the reacting substances are very finely divided, reactions will take place at ordinary temperatures which would not be considered possible if we considered the ordinary state of the substances in question. In fact, the existence of such "after vulcanisation" phenomena as described by Prof. Hinrichsen was inferred by me in my first paper on the subject (Zeitschrift für Chem. und Ind. der Kollöide, 1910).

It appears from the discussion that especially the question of the "after-vulcanisation" has aroused considerable interest. On this point interesting results are to be expected, just as the physico-chemical ways of observation have given us valuable points of view. It is very desirable that the problem of vulcanisation be studied experimentally and by as many scientists as possible.

The Adaptation of Different Raw Rubbers for Manufacturing Purposes.

By J. JAQUES.

It is intended in this paper to give my impressions, from a commercial standpoint, of the relative merits of various cultivated and uncultivated rubbers for manufacturing purposes. These opinions have been formed, after several years' practical experience in rubber mills, where the employment of different raw rubbers, and the production of a varied range of articles, was a matter of daily routine; and also upon the information gained, during the last few years, while constantly making comparative tests with the undermentioned kinds of rubbers.

The specimens examined were from all parts of the rubber-growing zone, and comprised most brands; first latex and hard-cure Para (*Hevea Brasiliensis*), Rambong, Castilloa, Funtumia, Pontianac or Jelutong, and others.

Details as to the various machines made use of, many of which may be seen working here at the Exhibition, will be found in a book entitled "Rubber," published by Sir Isaac Pitman & Sons, as well as in other publications dealing with the subject.

A point to bear in mind when examining rubbers, is that different brands should be subjected to treatment calculated—from close observation and experience—to bring out prominently the best features. They should, in fact, be treated according to the several purposes for which they are most likely to serve.

Generally speaking, the physical qualities of vulcanised No. 1 latex compounds, are identical with those characteristic of hard-cure Para. The tensile propertes of the cultivated are usually equal to, or of a slightly lower order, than indigenous Para. There are well-known smoked and some pale qualities, however, which are beyond question, of a higher grade, than the average hard-cure Para. A disquieting feature with a few cultivated *Hevea* sorts, is the difficulty experienced when breaking down and masticating them on the hot mixing rolls. Some of these rubbers do not soften readily, and in fact, it is impossible in many instances, to obtain a calendered sheet worthy of the name and at all suitable for high-class work. With the addition of softer rubbers, oil, wax, or substitute, a fine smooth sheet could, of course, be easily made; but the manufacturer cannot be expected to resort to these expedients when making goods of the highest grade for he can get the required effect by simply using hard-cure Para. As these cultivated rubbers, which are not readily amenable to treatment on the mixing rolls, invariably feel quite firm, and are often attractive in appearance, one is bound to remark that tough raw rubbers, having the appearance of possessing plenty of "nerve," are not necessarily the best for manuacturing purposes.

Having said this much regarding the difficulties encountered when working with certain plantation *Heveas*, some observations in favour of the product will not be out of place.

There are cultivated *Heveas*, which are even more amenable on the mixing rolls than hard-cure Para, which calender as well, vulcanise more readily, are stronger, and are in fact just as adaptable, as the best native rubber, for any requirement of the manufacturer. Plantation rubber also possesses that desirable state in common with the latter, that when vulcanised under the right conditions, " maturity " gives to it increased strength and " mellowness."

During the earlier stages of the planting industry, many planters were astonished to hear that the manufacturers deemed it necessary, in fact were compelled, to wash the rubber. That such a cleansing should be required, with rubber free from visible impurities, was called in question at the time, but that manufacturers acted with justification, would have been thoroughly understood by rubber growers, if they had had an opportunity of observing the behaviour on the mixing rolls, of many sheets and biscuits made, possibly from latex from young trees and prepared under unsuitable conditions, and which had not afterwards been cleansed by washing during the conversion of the latex into dry rubber. Sheets and biscuits so prepared, had, and in instances at the present time, have a tendency to deposit a substance of a sticky nature, on the rolls of the mixing machine, which causes the mineral matter, entering into the composition of the rubber compound to adhere and to form hard scales or flakes thereon. Such an occurrence results in the production of a mixture containing particles of mineral matter which under the circumstances could never enter into intimate combination from a mechanical point of view with the rubber, to form a homogeneous compound anything like the equal of a properly mixed batch.

Castilloa, Rambong, Landolphia, Funtumia and Guayule rubbers are softer and compare unfavourably with *Hevea*. For example, with *Hevea*, a manufacturer could produce goods, having such diverse properties as threads and matting ; but though he could make an excellent solid tyre and, of course, matting, from the former rubbers, he would find it difficult or impossible to turn out threads. So long as *Hevea* rubber remains at its present price, these rubbers will deservedly find a ready sale for the purposes mentioned. Moreover, since the cultivator and rational collector has become interested in the marketing of these rubbers, a higher standard has been reached, and with the application of improved methods of preparation, it is hoped to substantially increase their scope of usefulness to the manufacturer.

Passing now to the second part of this paper ; viz., compounding, rubber in its pure state is used as a first coating for the wires of cable, and is invariably employed as one of three coats or plies, which serve as an insulating sheath for the stranded cable or single wire. The sheets from which the strips of rubber or the narrow bands laid on the wires, either spirally or longitudinally, are cut, may either be " spread," " calendered " or " cut sheet." The one having perhaps the greatest application is spread sheet. This is prepared by applying a number of coats of a thick solution or dough made of rubber in coal tar naptha, until the requisite thickness is reached. This is applied to a long cloth, which then passes over the steam chest forming part of the spreading machine. This is done for the purpose of driving off the solvent. The cloth must be treated before being served with the rubber dough,

with a paste made from such substances as flour or starch, so that the finished rubber sheet can be easily removed by simply passing the spread cloth through water.

Calendered sheet is made from masticated rubber, which when warm is formative. The sheet is produced by merely feeding the soft rubber between the heavy hot rolls of the calender, from whence it issues, in a flat span of the required thickness, say one yard wide and a score or so long.

Gutta-percha and paraffin-wax sometimes enter into the composition of calendered sheet. This addition must not be treated as an adulterant, but rather as a means for increasing its insulation value. Paraffin wax is said to retard or prevent any deterioration due to oxidation, therefore it has a special function.

The spread sheet is stronger than the calendered sheet ; which has to be very carefully run, so as to avoid the formation of air bells which if present to any extent are liable to impair the insulation efficiency. Where air bells have been, they are certain, though small, to cause the sheet in their vicinity to be thinner, and hence weaker both electrically and physically.

Another form of sheet is known as " cut sheet." Cut from a solid block, that has been prepared from softened rubber, by enormous pressure and subsequently " aged " by freezing for some considerable time. This sheet, though excellent, strong, and almost indispensable for some classes of rubber goods, such as surgical commodities, thread for weaving purposes, etc., is, however, not extensively used for cable work.

These pure sheets may also be made up into goods, such as—to name a well-known line of articles—the best tobacco pouches, and then vulcanised by the cold cure process. The vulcanising medium employed is a combination of carbon bi-sulphide and sulphur chloride. The action of a comparatively weak mixture say 100–2 is rapid and effective, for either an immersion into the liquid, or an exposure to its fumes, will cause vulcanisation to take place in a few seconds or minutes, according to the thickness of the rubber. This method is also used for vulcanising dipped goods ; for example—teats. This article for the nursery is often made by dipping moulds or cores into an easy running rubber solution, and the teats are taken off the mould quite easily when vulcanised. When the cold cure process is utilised, the vulcanised rubber is washed first in a weak solution of carbonate of soda and then in clean water.

For the preparation of compounded rubber mixings, that is, intimate mixtures of mineral substances and rubber, a mixing machine is used, and before the purified rubber is in a condition to readily and satisfactorily receive these minerals, it must be reduced to a soft and plastic state by mastication on the hot rolls of this machine. From, say, 5–10% of sulphur is then added—the exact percentage being controlled mainly by the resin content of the rubber used. Some brands of rubber are not suitable for this type of mixing. This masticated rubber serves as a compound which can be made up into bicycle inner tubes or covers of capital value. Should a stronger compound be required for the manufacture of, for instance, motor tyre tubes, small additions of magnesium oxide, lead oxide, red iron oxide, antimony sulphide and the like, will provide a composition for the fabrication of drab or red inner tubes, and with further minor modifications, rubber corks can also be made from a compound of this description. The relative approximate tensile properties of the various example compounds mentioned will be given later.

Again, taking a commodity entirely different in physical properties: On the addition of larger amounts of sulphur to the pure rubber, up to, for instance, 50 per cent., calculated on the rubber we obtain upon vulcanisation that beautiful black, hard rubber termed ebonite. If certain amounts of vermilion or antimony sulphide, red iron oxide, etc., be also added to this sulphur and rubber, we get the red dental rubber used in the manufacture of artificial teeth, and upon the inclusion of other ingredients, usually secret preparations in the constitution of this mixing, with substances like sulphide of zinc, the pale or pink-tinted article.

Before proceeding further some explanation of the function of sulphur is perhaps necessary here.

The particular character of the action of sulphur on rubber under the influence of heat is, I believe, both chemical and physical. As, however, it is somewhat of a problem, I would refer you to the literature on the subject. Let it suffice, for the purpose of this paper, to state, that when sulphur is intimately mixed with raw rubber, and the homogeneous body is exposed to a temperature just above the melting point of sulphur, say 120° C., and upwards, for a definite period, within well-defined limits of course, the rubber assumes a state of permanent elasticity, or resiliency, and freedom from adhesiveness, when before this treatment it was plastic and sticky. The duration and intensity of the exposure is controlled by many considerations, to name a few: (1) The resin content of the rubber; (2) the amount of sulphur and sulphur carriers in the compound; (3) by the thickness of the rubber; (4) by the class of article being vulcanised and so on.

The vulcanising medium is generally superheated steam, but dry heat or other practical means is essential for articles like waterproof garments, goloshes, etc., having a deal of cloth in their make-up, which would absorb moisture if made by the former method, with deleterious consequences.

Reverting to compounding, another widely used commodity, namely, motor tyre covers, will serve to convey an extended notion regarding the useful employment of mineral matter as components.

Motor tyre covers are generally made from two distinct compounded rubber mixings. That is, the tread differs from the body or case, and is made from materials, which impart to that section coming into direct contact with the road surface, a condition much more suitable to withstand the heavy strain and rough usage occasioned while working. The tread is not so elastic or resilient, but it has a greater capacity of resistance to friction than the body. It usually contains less rubber and a greater percentage of sulphur, and sulphur carriers, viz., lime, magnesium oxide, lead oxide, etc. The reason for the extra sulphur and carriers is necessitated by the fact that an efficient vulcanised product is required in a shorter period than that required for the mixing from which the body is made. For it is imperative that the body should be highly flexible and resilient, and that condition can only be properly obtained from a mixing having a high percentage of rubber, a low content of sulphur and just sufficient mineral matter (such as zinc oxide and those already mentioned), to give it a certain toughness. Furthermore, when the tread has worn the body must usually stand another dose of vulcanisation if a new tread is fitted. That being so, you will readily grasp the reason for the percentage of sulphur being low in the mixing from which the body is made, for under this restriction any depreciation of moment is unlikely to occur during the renewal of the tread. The sulphur in the body compound being small, it has nearly all combined with the rubber during

the original vulcanisation, so very little free sulphur remains to continue this process, and consequently any depreciation in quality which may happen to a tyre under repair, is not so much due to the action of the free sulphur as to the extra heating given. The tread of a tyre is usually attached as an endless band in the partially vulcanised (cured) or unvulcanised (uncured) state to the body, after that section has been moulded and vulcanised up to almost its best point. A thick layer of solution (the compound of the tread in coal tar naptha) is brushed on to the roughened surfaces of the body and tread to come together, which, when the solvent has evaporated, are attached and well rolled. All visible air cells are removed with prickers. A spiral wire coil, or sectional core of wood is placed inside the made-up tyre, the whole being then lapped spirally with a narrow band of damp calico, and vulcanised in that condition. The calico serves as a mould, and the many edges left on the tread by the decreasing width of the rubber strips used when building it up, are obliterated.

The body mixing may contain up to, for instance, 80 per cent. or more of pure rubber, the tread 50 per cent. The rest of the mixing is made up of sulphur (usually flowers of sulphur) and the minerals already mentioned together with talc, carbonate of magnesia, lamp black, and so on, all incorporated in a finely divided state with the rubber.

With regard to solid tyres, their composition is similar to that of the tread of the pneumatic tyre. The two compounds differ mainly, not in the amounts, but rather in the kind of raw rubber and minerals each contains. Up to the present very little cultivated rubber—the supply of the quality required is probably not equal to the demand—has been utilised for their manufacture. A soft rubber containing more resins than *Hevea* is invariably preferred, and that obtained from the Congo (Landolphia), and similar kinds, meets the requirements of the manufacturer. It is essential, as these tyres are shaped by being forced on a tubing machine through a die, that the compound should be soft and formative, but firm, without having to undergo over working. The desired effect is gained by using the softer rubber referred to, or certain waxes and oils in small proportions as softeners, if *Hevea* rubbers be used. As the mineral matter is chosen for its hardening property to enable the tyre to withstand heavy working loads, lamp black, French chalk (talc), magnesium carbonate and the like are selected.

In the course of this paper several classes of goods have been taken as being excellent means for illustrating the usefulness of special minerals in rubber compounding for the manufacture of commodities having different uses. The grades or qualities of raw rubber suitable for the production of the articles mentioned are as follows :—

The highest grade *Hevea* rubber, either cultivated or uncultivated, is pre-eminently the rubber from which to manufacture the first coating for cabl wires, threads and surgical goods, on account of its reliability, strength and durability, under the very severe trials these articles are subjected to. The manufacturer does not find it profitable to use even lower grade *Hevea* for this purpose. On the other hand he does utilise Castilloa, Rambong, Landolphia, Funtumia rubbers and others as the material for making tobacco pouches and teats, but it is doubtful if even the cleverest manufacturer could make a satisfactory hard-wearing pouch from the highly resinous Guayule rubber without the addition to it of one or other of the former brands. The best pure rubber articles are those made from *Hevea*, and this statement also refers to the lightly compounded rubbers for bicycle and motor tyre tubes and covers ; though for such

purposes the experienced manufacturer can manipulate good class rubbers other than *Hevea*, and produce goods of sound value, durable and resilient.

Motor tyre treads can be, and are, manufactured successfully from the lower grade Heveas, Castilloa, Landolphia and similar brands. This part of the tyre contains a good deal of mineral matter which increases the tensile strength and aids the tread to resist friction. Moreover the use of the best *Hevea*, even allowing for the increased strength and durability obtained, would be rather an extravagance, as the life of a tyre tread is comparatively short even when made of the finest material.

All classes of raw rubber are used by the solid tyre manufacturer, and it cannot be said that if he used the highest grade *Hevea*—that is if the price allowed it—his goods would give greater satisfaction to his customers. However, as before mentioned, and for the reasons given, Landolphia, caucho and similar rubbers are the brands he uses.

Pontianac when washed is used without further refining in conjunction with raw rubbers of a higher grade—as the base of a compound which is spread as solution on to asbestos cloth and paper to be made into steam packing and so on.

In conclusion, I have been able to compile, with the permission of Mr. Clayton Beadle and Dr. Stevens, an interesting table, giving the approximate tensile strength and elongation at break respectively, of the prepared rubbers and compositions dealt with. The highest figure yielded by each test has been placed at 100.

	Stretch and Break.	Breaking Strain.
(1) Pure prepared rubber sheet, unvulcanised ..	34	15
,, ,, ,, ,, vulcanised ..	88	64
(2) Rubber and Sulphur	100	47
(3) Rubber and sulphur, with small additions of antimony sulphide, oxide of zinc, oxide of magnesia, etc, inner tubes and tyre body ..	67	68
(4) Rubber and sulphur, with larger additions of various minerals mentioned, tyre tread ..	48	100
(5) Rubber and sulphur, with minerals as described, solid tyres	30	100

The Technical Use of Plantation Rubber and the Conditions which, in the Production of Raw Rubber, are of Importance for its Technical Application, with Special Reference to *Kickxia* (*Funtumia*) and *Manihot* Rubber.

By Dr. FRITZ FRANK.

Dr. Esch occupied the chair during the reading of the paper and also during the majority of the discussion.

The cultivation of rubber may be said to date from 1876, though regular plantations did not then exist. In 1882 the first tapping tests were made; they were not very encouraging as to yield. In 1885 further experiments were made, involving, among other methods, cutting down the tree, and by this latter method, from trees about 8½ years old, 1½ lbs. of dried rubber were obtained. In 1889 1,100 lbs. (in round numbers) of rubber were exported from Ceylon. This fact marks the beginning of the *plantation production* of rubber, for it was then proved that technically useful rubber could really be obtained from trees grown in plantations. I will here omit details as to the different cultivation experiments, for it may be assumed that all attending these Conferences are familiar with these matters. In 1899 the rubber exports from Ceylon had only risen to 7,900 lbs., and ten years later to something over 1,000,000 lbs. Since then the use of plantation rubber by manufacturers has increased enormously.

In Africa the plantation cultivation of rubber came much later. The pioneers in West Africa were Professors Preuss and Warburg, and in East Africa Professor Zimmermann, Herr von St. Paul Illane, Herr Köhler and Herr Zaetsch started the cultivation of *Manihot*. The first plantation trials followed each other quickly, for the work of the Biological Institute of Agriculture in Amassi, working in co-operation with the planters, made it possible to put the cultivation of *Manihot* on an experimental footing—which previously appeared hopeless. Here, too, we have had a relatively enormous development. I cannot here enter into the question whether these enterprises are suited to the localities and whether they promise results which will make them remunerative. *Kickxia* and *Hevea* appear fairly certain to do so, and probably *Manihot* as well, thanks to the work of Sandmann. Much still remains to be observed and much to be learned however. The data which will decide as to the continuation of these plantations will be available very shortly.

The costs of production for *Hevea* are becoming lower year by year, given suitable soil and climatic conditions, and it appears to me fairly certain that the tapping method, even though complicated, can be carried out by our African negro labourers. In the cultivation of

Kickxia experience has been gained which should be useful to the planter in deciding one way or the other the question whether we shall continue to plant in the old manner and only *tap* the trees, or whether, following the proposals of Ferranc and the previous suggestions of Zimmermann and Eduardoff, the plants shall be allowed to shoot up as in their wild state, at comparatively small distances from each other, and then, during a certain period of their development—to be fixed by experiments—be cut down. In this way a fairly practical forest management could be instituted, for aftergrowth would come up in sufficiently large quantity to provide for a periodical thinning out. According to my way of thinking, it would be a mistake to cut periodically *all* the trees. The "continuous-forestry" method, on the other hand, could be worked very cheaply, as it would cost little for maintenance for clearing, etc., would not be necessary. An experiment along this line might well commend itself to planters. For *Manihot* also this method does not appear to be impracticable, according to experiments made by Zimmermann and Eduardoff, who found that working in this way good results could not be obtained. Unfortunately, so far nothing has been published with regard to further experiments with *Manihot* culture by this method. According to our way of thinking, however, the vital question in the cultivation of this tree is that of harvesting methods.

Not only the methods of cultivating the trees but also the harvesting conditions and the manner of preparing the latex are of the utmost importance in determining the usefulness of the rubber. I am very well aware that these questions lie at least in part, beyond our working limits: but we must, nevertheless, give them our active interest, because we have found long ago that the value of the rubber depends upon the conditions of growth and harvesting. It is absolutely necessary to produce plantation rubbers in such a manner that they can be used at once in certain branches of manufacture; or, better still, generally, for the manufacture of rubber goods. The questions which have to be solved in order to bring this about begin with the costs of the work on the plantations and finish with observations regarding the goods manufactured from the rubber.

It will be well to enumerate the individual questions. The first is, as already mentioned, that of the costs incurred on the plantation, from the planting of the tree to the production of the matured rubber. Next comes the question of the soil, which, as we think, has not been accorded the attention it merits. This is, of course, an outcome of the circumstances. It was not possible to draw at once a conclusion from the examination of a soil whether the rubber grown on it would be technically valuable or not. Many years' experience had first to be gained by observing how the trees develop in certain soils, noting the effects of climate and studying the influence of the various soil constituents on the rubber produced. For some time we have been endeavouring to collect data founded on comparative examinations in the hope that it might prove possible to draw conclusions from an examination of a given rubber as to whether it had been grown on soil containing the necessary nourishment for this particular tree. Of course, the conclusions would be only relative and will be modified by climatic variations. This evidently involves a very large amount of work.

The important question of artificial fertilizers also comes up in this connection, for it is certain, in the light of experience gained. in examining rubbers from different countries that in cultivating rubber trees a suitable soil is absolutely necessary.

I now pass on to the point which I consider the most important (next to the soil question) in determining the value of the product obtained. I refer to the mode of preparation, the preliminary working, and the shipping and storage of the freshly harvested rubber. This very important part of the rubber plantation management has for a long time been accorded scant attention, and is as a rule characterized by rather illogical methods. Some of these have been taken over direct from the natives, who sometimes evaporated the latex, sometimes smoked it, and sometimes coagulated it with the aid of their own perspiration. From the smoking process the use of acetic acid has light-heartedly been deduced, for one reason because acetic acid is present in the smoke from wood, and also, perhaps, because it was noticed that the acid when added to latex usually brought about the desired coagulation. The use of other organic acids has probably been deduced from the native use of perspiration, and the use of plant decoctions led to the use of tannin and like substances.

The composition of the smoke of the Urukuri nuts used by the *seringueros* was only superficially studied. Working with Herr Guädinger, I have begun studies in this direction, and hope to be able to communicate results at an early date. The work is very complicated. The procuring of the material caused great difficulties, which have, however, been overcome by the kind co-operation of the German Consulate in Brazil, and I hope to furnish satisfactory answers to the many questions with the aid of the excellent material I now have at my disposal. It must be kept in mind that smoke contains not only the products of dry distillation, but products of insufficient combustion (empyreumatic oils, etc.), and that these two may be active agents in the smoking process. Another important point for study seems to me to be that the Brazilian native does not separate anything from the latex, except the accidental mechanical contaminations. He smokes it entire. This important fact has for the most part been regarded as a negligible element in the derived methods of coagulation by the action of acids and chemicals.

As to the use of chemicals and drugs, it may be stated that all salts, all acids and astringent substances which coagulate albumen and curdle milk are suitable for separating rubber from latex. But *very great care should be taken to choose really suitable ones*, and in each case it should be carefully considered whether it is best to separate the rubber from the serum or to dry it (with addition of sterilizers) with and its so-called contaminations!

Much the same remarks apply to the working of the rubber after its separation from the serum, *i.e.*, after the drying-up process. Here, as well, a comparison of the results obtained by different methods of treatment might be practicable. The results, rightly interpreted, might well lead to conclusions of far-reaching importance. Regarding the drying of the rubber, its storage in the tropics, and the manner of shipping it much has already been said and done, and I might consider work in this respect as, broadly speaking, concluded. The experience gained all tends to show that the drying should be done in only diffused light, at the most; better still, in the dark or under red light; and, if possible, without artificial heat. Drying in vacuum I should absolutely condemn in any case, even though good results may have been obtained with this method here and there. I refer, of course, to *the preparation* of the rubber on the plantations and not to the handling of it in the factories, for there the rubber often has to be dried and handled quickly. The shipping conditions come in next for consideration, and I think we may congratulate

ourselves that the former mode of sending rubber in bales and sacks has been completely given up. To-day, I think, the whole of the plantation rubber, at least all that is conscientiously treated, arrives here in cases.

I have thought best to deal with the foregoing points at some length for they and the correct logical sequence of the separate steps are, in our opinion, all important in their bearing on the technical suitability of the plantation rubber.

I have already, in an article in the handbook of the exhibition, drawn attention to the fact that it is in the highest degree desirable to bring about uniformity in the methods of preparing rubber on the plantations in order to prepare the way for a standardization of plantation rubbers, which would greatly increase their usefulness. For years we have been engaged in an endeavour to ascertain what particular points most affect the quality of plantation rubber. To-day we can say with confidence that the suitability of plantation rubber is dependent on climatic and soil conditions, and on the manner in which it is prepared. The tree species is only of secondary importance, though, of course, it has its influence on the value of the rubber. There is no doubt that *Hevea* rubber, if fairly carefully prepared, will always be considered as the most generally suitable product ; on the other hand, *Kickxia* rubber, for instance, has not been regarded as possessing the same technical value. *Manihot* rubber, too, was at first used only for certain purposes, partly because its characteristics were not fully known and partly because it presented a less attractive appearance as offered in the market. It is now a number of years since we found that the latter, when used in correct fashion was just *the* material for articles which are to be subjected to pressure and friction. These conclusions were, to our satisfaction, generally confirmed, and this rubber is now much esteemed in all lines of work. Unfortunately its market value is not commensurate with its usefulness, and it is just this fact which leads me to here speak of the real value of *Manihot* rubber.

Markwald and I have proved in a joint research that the mode of preparation is of far greater importance than was at first supposed, even in case of *Manihot* rubber, which seems to coagulate under almost any condition. According to our experiments it appears beyond doubt that certain acids or plant products act in such a manner, during coagulation of *Manihot* rubber, that they make it firmer. Among the various coagulants tried, none has given so good a rubber as the juice of the wild lemon. We may mention, *en passant*, that we have lately had a similar experience with a number of tests on *Hevea* rubber. In another case, however, owing to suitable soil, where " Purub " separated from *Manihot* latex, a rubber far above the normal, in strength and nerve, soil conditions appeared to be the real cause. The tables on view will demonstrate this. They refer to the product from Ngomeni. Unfortunately, the new Amani sample of *Manihot* rubber which had been coagulated by " Purub," according to the Sandmann-Bamber process, was too small to allow a complete examination. The vulcanization of this sample was particularly ready and decided.

Partly through our work, then, the high value of correctly prepared *Manihot* rubber, for special purposes—that is, for articles which are to be subjected to pressure and friction—has been established. On the other hand, we have been able to prove the suitability of this rubber for " patent rubber " goods, a line in which only really suitably prepared products are of any use. Unfortunately the methods of preparation are still confused, and everything that is accomplished in this department

is in a certain state of ferment. People cannot yet resolve upon a standard method of working, even though good results may have followed its use. This can only be explained by the fact that we look too much to our neighbour and try to transplant methods of preparation from land to land without regard to climate, conditions of soil, or the kind of tree in question. All experience indicates that on no account should *Manihot* rubber be strongly worked mechanically in the Tropics. The injurious effect of such treatment appears from the observed fact that rubber which has been prepared in first-class style and has arrived here in splendid condition, produces goods which show a more and more pronounced lessening in value in proportion as the rubber according to the amount that has been done to the rubber mechanically in preparing it.

If, then, a robust rubber, like *Manihot*, is so strongly modified by variations in the coagulant and in the mode of preparation, how much more must this be true of the sensitive *Funtumia* rubber which it has taken years to get accepted as technically useful in the cultivated form? The comparatively easy decomposition of this product naturally made manufacturers shy. They could be guided only by their own experience and observation as to the durability of their goods, and thus the much lower value of *Kickxia* rubber is readily understood, though it is the real offspring of the "silk rubber." To-day when means are at hand by which the value of raw rubber can be determined by chemical and physical methods, the manufacturer can no longer say to the seller:—"It will be necessary for me to watch goods made out of this rubber for years before I am sure it is right." To-day the proof is furnished that from *Kickxia* rubber goods can be made which are not only elastic, but "nervy" as well. Though, of course, only by employing methods adapted to the local circumstances.

Everywhere it has appeared that acetic acid is a comparatively unsuitable coagulant. It has taken a long time to realize that acetic acid is not simply inert, and even now this idea is not generally recognized. Theoretical considerations have been lightly put aside in the same way as coagulants are put away. Only the demonstration that acetates are not free from objection, and that they are very soluble in water and hygroscopic, have opened the eyes of many. This demonstration has come from the scientific and technical laboratories, and it takes a long time for a truth ascertained in a laboratory to find its way to the plantation. To-day it can be asserted that acetic acid is in any case a most unsuitable coagulant. This fact being clear, it is easy to understand that faulty coagulation more than anything else accounts for the lack of confidence in plantation rubber.

In detail these are the reasons:—The hygroscopicity of the acetic acid salts, their great solubility in water and their liability to decomposition under vulcanizing conditions. This ready solubility in water has the effect of removing the most effective of the mineral components from the rubber. The other points in question have been previously dealt with.

What has been said of *Manihot* and *Kickxia* also applies to *Hevea*, *Castilloa* and *Ficus*, and it is of importance that in these cases also the experience gained in one place should not simply be transferred to another, but that the special conditions of the particular plantation should first of all be taken into account, and that also at every stage of production and preparation.

We may consider it proved that under suitable conditions plantation rubber can enter into free competition with wild rubber, and this may

certainly be regarded as a gratifying result of scientific endeavour in this field. I have no doubt that by systematic work it would be possible to find for every plantation a method of preparation which would meet its special conditions in such a manner that perfectly first-class products, fully equal to the wild rubbers, would be produced.

Plantation rubber is in no way inferior to rubber grown in the virgin forests; it is only the conditions of cultivation and the mode of preparation that have placed this international asset in a temporarily unfavourable light.

Dr. Esch: I think I express the views of the whole Conference when I thank Dr. Frank for his very interesting paper. I will only make a few remarks from my own standpoint. I should like to ask if I correctly understood him that in the case of *Hevea* rubber the attempt of the Amazon worker is to get quite dry rubber. I beg to state that it is not true that rubber in the Amazon Valley comes out quite dry. It is in a very wet condition and contains nearly 15 per cent. of moisture. The planter only wants those portions of the latex which are easily coagulated by means of the smoke. The parts that remain in the pan, and which do not undergo coagulation by means of the smoke, give the scrap rubber. Gentlemen interested in this question may like to hear my lecture which I shall give to-morrow, entitled, "Some Remarks on the Preservation of Rubber and Conclusions as to the Preparation of Plantation Rubber." As to the use of acetic acid. Dr. Frank has stated, if I correctly understand him, that acetic acid is the worst of acids for coagulation. I will ask Mr. Clayton Beadle, as the representative of an English laboratory that is greatly interested in plantation rubber, to make some observations on that point, because nearly all the plantations in the East use acetic acid.

Mr. Clayton Beadle: Do I understand rightly that there is 50 per cent. of moisture contained in the rubber after coagulation?

Dr. Esch: 15 per cent.

Mr. Clayton Beadle: That agrees with the shrinkage.

Dr. Esch: It is only Amazon rubber.

Mr. Clayton Beadle: With regard to the point you mentioned, I am afraid I cannot give you much information and that is very negative because of all these mineral and other acids which have up to the present been tried, nothing appears to give a better result than a small quantity of acetic acid, with an emphasis on the "small." No more acid should be used than is necessary to complete a proper coagulation, and if any excess of acid over and above what is necessary for the proper completion of coagulation is put in the rubber it is certainly not likely to give such a good result. Mineral acids may have been tried and used, but there is nothing to show from all the work that has been done that they give any better results than acetic acid.

Dr. Esch: I may say that I have asked several large planters, and they tell me that acetic acid is now the acid for the coagulation of plantation rubber in the East—in Ceylon as well as the Malay States. I may say I agree with the remarks of Mr. Beadle.

Dr. Stern: In the coagulation by acids, is it the hydrogen ion plays the controlling part, or has the anion also some influence?

Mr. FOL: According to Victor Henri the explanation is that the hydrogen ion brings about the effect, as is shown by the fact that as one uses more and more strongly dissociated acids a less and less volume is required to do the work. These observations are also supported by the work of Spence and others.

Dr. ESCH: I spoke with Dr. Spence on this point, and he is of opinion that if possible no acid should be used at all, but it seems to be impossible that we can renounce the use of any acid. Dr. Spence is now of opinion that only those acids may be used which cause no harm to the rubber. He has made special researches, and it seems to be remarkable how difficult it is to wash away the last traces of several acids. It is not difficult to get away the carbonic acid or the last traces of formic acid. It is even not difficult to get away the last traces of acetic acid, but Dr. Spence is of opinion that there are several acids that can be used, and he has promised to give me a paper for publication on this point, but I have not received the manuscript.

Mr. POTTS: It seems to me that an interesting line of work might be something in the line of what Dr. Spence has done to determine the adsorption of certain acids, because it is possible that, when the acid is added, a certain amount is adsorbed. The various acids would adsorb in different ways.

Dr. HUBER: I think Dr. Esch is mistaken in his opinion about the formation of scrap rubber. If I understood him aright, he thinks that scrap rubber comes from the latex which is not smoked.

Dr. ESCH: That was a misunderstanding. The portion which remains in the pan is added to the scrap rubber, but it is not the only source of scrap rubber.

Dr. HUBER: What is left in the pan is not rubber which has not been coagulated in the smoke; it is superfluous latex left in the pan. Finally there is a residuum. This is allowed to dry, and it commences to dry even during the operations. It is only a small amount of latex which cannot be added on the form.

Dr. ESCH: Of what region are you speaking? I have had different reports from other parts.

Dr. HUBER: The lower Amazon and some parts of the upper Amazon. I do not know all the districts where rubber is prepared. It would be necessary to travel for several years to see all the different regions.

Dr. FRANK: I have confirmed the results given by Mr. Beadle, as to the residual acid in Para and in plantation *Hevea* rubber.

Mr. CLAYTON BEADLE: I understand Dr. Frank repudiates a statement made some time ago that hard cured Para was liable to an alkaline reaction. Do I understand that to be the case, and that he finds it is not so? I might mention that we have never come across a rubber in the prepared state—a *Hevea* rubber—that showed an alkaline reaction. Some time ago we procured hard cure Para from various sources with the object of investigating that point and we found an average in four or five samples of 0·1 per cent.—expressed as acetic acid—though we did not ascertain whether it was or not. Now, in regard to unwashed plantation rubber, we have found an average figure very slightly higher—I do not know the exact figure, but between 0·1 and

0·2 per cent. The view that most of the acids can be removed from the washed plantation rubber is borne out by our figure of ·017 per cent.; so that in spite of all the talk about the harm of using acetic acid it is interesting to note that the actual amount of acidity in plantation rubbers now being prepared is something about one-fifth of the amount of acidity to be found in hard cure Para as it comes to market. No doubt the conditions of combustion in the smoking of hard cure Para give rise to the formation of acetic acid. There appears to be as much acetic acid contained in the fumes and absorbed by the rubber in hard cure Para as there is put into, or retained at any rate, by the plantation rubber as the result of using small quantities of acetic acid.

Mr. Fol: How could any alkaline reaction possibly be explained?

Dr. Frank: By decomposition of albuminoids.

Mr. Fol: Were the tests as to the action of different coagulants made in the laboratory or on the plantation?

Dr. Berkhout: I have followed Dr. Frank's remarks with the greatest interest. Planters and manufacturers cannot be too grateful that men like him are bestowing all their time on the study of rubber, a material with more whims than a spinster. Dr. Frank will certainly not take it amiss if I take some exceptions to his lecture. *Funtumia* plantations cultivated on an artificial forest regeneration plan would be, I entirely agree with him, very well worth trying, but one never should fancy that such a business consists only in clearing the jungle and after that sowing the seeds. Leave such plantations without careful attention and when you come back some years afterwards to tap you will not find a single rubber tree.

Natural regeneration is not easy at all to manage and differs very greatly with different kinds of trees. Young beeches should be treated quite different from young oaks. In the tropics the conservator of forests should attempt to ascertain what operations are necessary for the natural regeneration of the different forest trees.

A private estate generally does not exceed 2,000 acres, while a forest block will comprise perhaps 200,000 acres. A private person in the tropics cannot be satisfied with a low rent. An extensive cultivation never promises ready revenues. If the standard of rent be high your expenses will be too heavy. Therefore it will be wise to leave *Funtumia* cultivation in the tropics to Government forest service.

Dr. Busse: After Dr. Frank's very interesting lecture, I would like to add a few words, although my remarks do not touch the chemical question which has been almost exclusively treated in this discussion. Dr. Frank has said that the india-rubber production is first and foremost dependent on climatic influences and the nature of the soil. This is without a doubt correct. In spite of this, however, it seems to me necessary to put another factor also in the foreground, which, as far as I know, has found up to the present but little attention. My friend Dr. Stuhlmann, at the meeting of the India-Rubber Commission of the Colonial Economic Committee in Berlin, pointed out that the production of rubber trees as a whole really a question of productiveness of certain definite species. Dr. Stuhlmann explained that the whole stock of *Manihot Glaziovii* in German East Africa has its origin in a single delivery of seed which came from East Africa about 20 years ago. Every tree in East Africa

took its origin from this particular seed, hence it is by no means improbable that the scanty yield of latex which is so often complained of with regard to the East African trees is traceable to a species peculiarly in the original seed.

If we look around among the most generally cultivated plants of the earth we will find among all species more or less marked great differences in the total outputs, as well as in the production of any particular material. In many cases production has been considerably increased, and species introduced through systematic breeding (selection of individual plants), which produce certain materials in an essentially higher degree than formerly. As it is rather late now I must restrict myself, and cannot go into details, but, on this point, I would like to draw the attention of planters to the experimental stations of those countries where rubber is produced as a result of comparative trials in raising materials of different origins, and through systematic comparative observations of the production of the individual plants, as well as the quantities of latex and of the percentage of rubber contained in the latex. The seed of certain special productive plants will be sown in order to find out if the excellent qualities of material is capable of progenity. Should that be the case, we would have found a means of increasing in time the productiveness of the rubber plantations.

Dr. Stuhlmann has begun already to make similar experiments in *Manihot* cultivation in East Africa by ordering from the different plantations of the earth certain seeds which are destined to be planted in East Africa. If the opinion repeatedly expressed in the course of our debates that the *Hevea* rubber of the Asiatic Plantations is of inferior quality to the wild Para rubber of Brazil, and if this opinion be based on facts, we can then not only explain it as due to the age of the trees, the influence of the climate, the nature of the soil, but also to the peculiarity of the species. Therefore we should have to examine whether the quality of the products could be improved by judicious selection. It will be a long and difficult task to come to a final judgment, a task which, owing to its nature, cannot be carried out by private planters. But, as this matter is of very great importance, trial stations would deserve great credit if they started work in this direction.

Dr. Frank: I wish to thank the Conference for the interest shown in my paper, and will now answer the different questions that have been raised.

As to the influence of the kind of tree mentioned by Dr. Busse, I did not put this in the foreground because it lies rather outside my line of work; but I did refer to it in connection with other matters, and am fully alive to its importance. However, I believe that even with the most careful selective cultivation, the soil and climate are always powerful influences—as shown by the records of *Hevea* in Ceylon and in the Malay Straits. In the latter locality the yields and the quality are always better, although the trees are the same without any selection.

With regard to Dr. Berkhout's suggestions: I agree with him entirely. I only used the expression "forest culture" because Farranc's proposal reminds one more of forestry than of plantation management.

I think these proposals of Farranc very valuable, because they make it possible to utilize regions which are not suited for *Hevea* cultivation for *Funtumia* and that without having to invest too much capital.

Experience as to tapping *Funtumia* is not encouraging up to now.

As to the action of acids in coagulating, this depends upon the concentration employed. In the smoking process of course acids and preservatives act simultaneously.

The alkaline reaction of raw rubber (serum) can be explained by the decomposition of albuminoids, notably in case of ceara and of caucho. I have already stated that the secondary decomposition products of albuminoids act unfavourably and that a good protection against such harm would be to leave the rubber wet—taking care, of course, the fermentation does not take place. The albuminoids themselves do no harm and mould is not of the slightest consequence.

The samples from which we have gathered our conclusions as to the influence of different coagulants were collected with the greatest care in Amani by Professor Zimmermann at Victoria and Mohu, and were handed over to us most carefully labelled.

The Extensibility of Vulcanized Rubber.

By C. CHÉNEVEAN and F. HEIM.

Laws of Extensibility.—Determination of the Distinctive Specific Qualities of Different Kinds of Rubber by Experiments on their Extensibility.

1. When a piece of rubber is held in the hand one has an almost instinctive impulse to compress it between the fingers; then, one of the hands being kept steady, the resistance opposed to the motion of the other gives an idea of the work required, and everybody, even a child, will then say when he feels the effort small that the rubber is very elastic.

Therefore one can understand why, for a long time attempts have been made to ascertain, by traction experiments on test samples either cut or moulded from the rubber itself, the quality of the rubber as indicated by this mechanical property of extensibility.

In this paper we shall study vulcanized rubber only, and content ourselves with stating that a study of raw rubber has convinced us that with regard to extensibility, only vulcanized rubber is worth considering.

We shall not at this time deal with the various apparatus or arrangements used in stretching experiments for all of them lead to similar conclusions the moment one has learned to handle them properly, and has sought out their respective sources of error.

Our main object is to give the results of our study on the extensibility of vulcanized rubber under progressively increasing loads.

If we ascertain by any method the elongation y of a test sample of length l, and thickness s, under the influence of a load x, we can plot from the measurements obtained a line which takes the shape of curve D (Fig. 1) or curve E (Fig. 2), according as the elongations are plotted as abscissas or as ordinates.

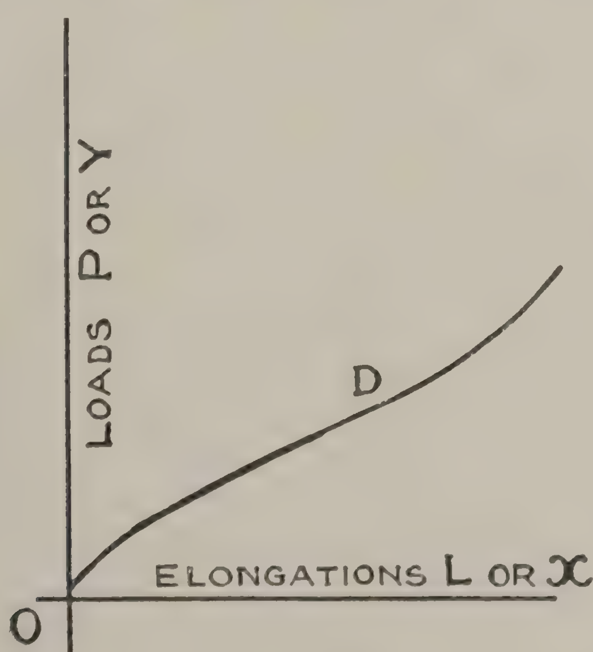

FIG. 1.

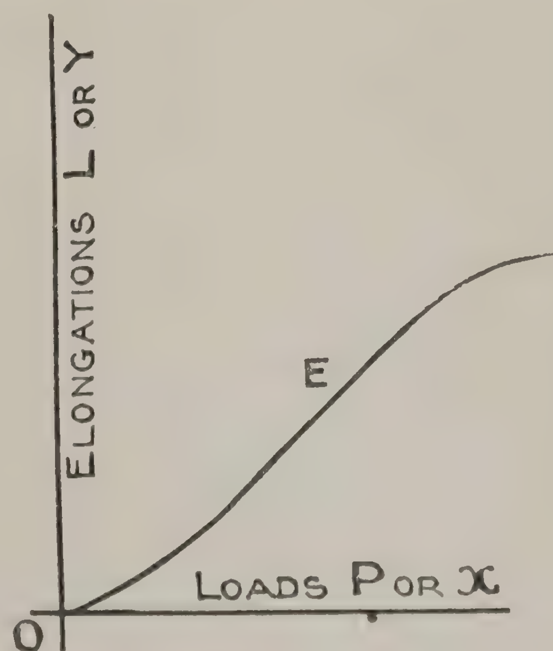

FIG. 2.

These curves have a characteristic S shape; they have already been obtained and described by numerous investigators (1); they are generally given up to the breaking point of the test sample. But while practical use has been made of these curves, it seems as if no one ever had troubled himself about the law they represented; *i.e.*, the law of extensibility.

One of us (2) was the first to draw attention to this point and to indicate a mathematical formula representing the curve E; this formula gives the elongation y of a test sample under the influence of a load x, in terms of three constant quantities c, a, b, and has the following expression:—

$$y = cx + a \sin^2 bx \quad (1).$$

We have verified (3) by tests on a great number of kinds of rubber of different origins, vulcanized under varying conditions, that the equation (1) represents the general mathematical formula of the characteristic curve of extensibility.

I.—Table Showing Some Results Obtained with Manufactured Industrial Rubber. (1)

Very Good Rubber. (Slightly Vulcanized, No additions.) $y = 5{\cdot}9\,x + 8{\cdot}6 \sin^2 90\,x$.

Charges x.	Elongation y. Calculated.	Observed.	Difference.
kg.	cm.	cm.	cm.
0·100	0·8	0·85	—0·05
0·200	2·0	2·1	—0·1
0·300	3·5	3·5	0
0·400	5·3	5·4	—0·1
0·500	7·25	7·2	+0·05
0·600	9·16	9·0	+0·16
0·700	10·9	10·6	+0·3
0·800	12·5	12·2	+0·3
0·900	13·7	13·5	+0·2
1·000	14·5	14·6	—0·1

Good Rubber. (Vulcanized, No additions.) $y = 4{\cdot}1\,x + 13{\cdot}9 \sin^2 40{\cdot}7\,x$.

Charges x.	Elongation y. Calculated.	Observed.	Difference.
kg.	cm.	cm.	cm.
0·200	1·1	1·1	0
0·400	2·7	2·5	+0.2
0·600	4·8	4·5	+0·3
0·800	7·3	7·1	+0·2
1·000	10·0	10·0	0
1·200	12·8	12·9	—0·1
1·400	15·5	15·7	—0·2
1·600	18·0	18·05	+0·05
1·800	20·1	20·2	—0·1
2·000	21·8	21·8	0

Middle Class Rubber. (Moderately compounded.) $y = 2.5\,x + 6.1 \sin^2 36.9\,x$

kg.	cm.	cm.	cm.
0·200	0·75	0·75	0
0·400	1·4	1·6	—0·2
0·600	2·3	2·4	—0·1
c·800	3·4	3·5	—0·1
1·000	4·6	4·6	0
1·200	6·0	5·7	+0·3
1·400	7·2	6·9	+0·3
1·600	8·5	8·3	+0·2
1·800	9·6	9·4	+0·2
2·000	10·2	10·2	0

Bad Rubber. (Heavily compounded.) $y = x + 1.4 \sin^2 53\,x$.

kg.	cm.	cm.	cm.
0·200	0·24	0·30	—0·06
0·400	0·6	0·7	—0·1
0·600	1·0	1·1	—0·1
0·800	1·43	1·5	—0·07
1·000	1·9	1·9	0
1·200	2·3	2·3	0
1·400	2·7	2·6	+0·1
1·600	3·0	2·9	+0·1
1·800	3·1	3·15	+0·05
2·000	3·3	3·3	0

(1) The designations are the empirical commercial designations. The under lined numbers indicate the stresses taken for the calculation.

(1) Stévart, Bouasse, Breuil, Schwartz, cte.

(2) Dr. Heim, "Récherches scientifiques sur les matieres premières," Paris, 1901, p. 74.

(3) C. Chéneveau and F. Heim, sur l'extensibilité du caoutchouc vulcanaisé. Cmptes Rendus, February 6th, 1911.

II.—TABLE GIVING SOME RESULTS OBTAINED WITH VULCANIZED NATURAL RUBBER.

Para Rubber.

$y = 1.6\,x + 8.7\ \sin^2 20.9\,x.$

x.	y. Calculated.	Observed.	Difference.
kg.	m.	m.	m.
0·2	0·33	0·40	—0·07
0·5	1·1	1·2	—0·1
1·0	2·7	2·7	0
1·7	5·8	5·8	0
2·0	7·1	7·3	—0·2
2·5	9·4	9·8	—0·4
3·0	11·8	12·1	—0·3
3·4	13·7	13·7	0

Other Para Rubber.

$y = x + 12\ \sin^2 15\,x.$

x.	y. Calculated.	Observed.	Difference.
kg.	m.	m.	m.
0	0	0	0
1	1·8	1·8	0
2	5·0	5·0	0
3	9·0	9·0	0
4	13·0	13·0	0
5	14·0	15·8	—1·8

Vine Rubber (Indo-China).

$y = 2.05\,x + 17.95\ \sin^2 55.1\,x.$

x.	y. Calculated.	Observed.	Difference.
kg.	m.	m.	m.
0·3	2·0	1·5	+0·5
0·6	6·6	6·6	0
0·9	12·2	12·2	0
1·2	17·4	16·7	+0·7
1·5	20·7	19·7	+1·0
1·8	21·2	21·3	—0·1

Clitandra Arnoldiana Rubber (Congo).

$y = 12\,x + 30.5\ \sin^2 57.6\,x.$

x.	y. Calculated.	Observed.	Difference.
kg.	m.	m.	m.
0·1	1·5	1·5	0
0·2	3·6	3·2	+0·4
0·6	17·0	17·0	0
1·0	33·7	34·0	—0·3
1·2	41·0	41·0	0
1·4	46·5	47·0	—0·5

Landolphia Thollonii Rubber (Congo).

$y = 6.3\,x + 7.7\ \sin^2 13.15\,x.$

x.	y. Calculated.	Observed.	Difference.
kg.	m.	m.	m.
1	1·0	0·8	+0·2
2	2·8	2·7	+0·1
3	5·0	5·1	—0·1
4	7·4	7·4	0
5	9·6	9·6	0
6	11·2	11·4	—0·2
7	12·1	12·2	—0·1

3. A few important points may be noted as to this first result. The extensibility curve E (Fig. 2) is made up of three very distinct parts, E_o, E_m, E_r (Fig. 3). *From a theoretical point of view* one could

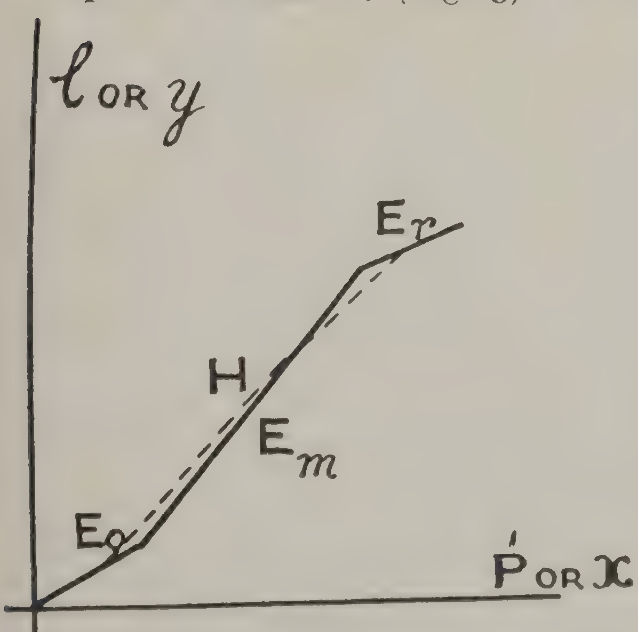

FIG 3.

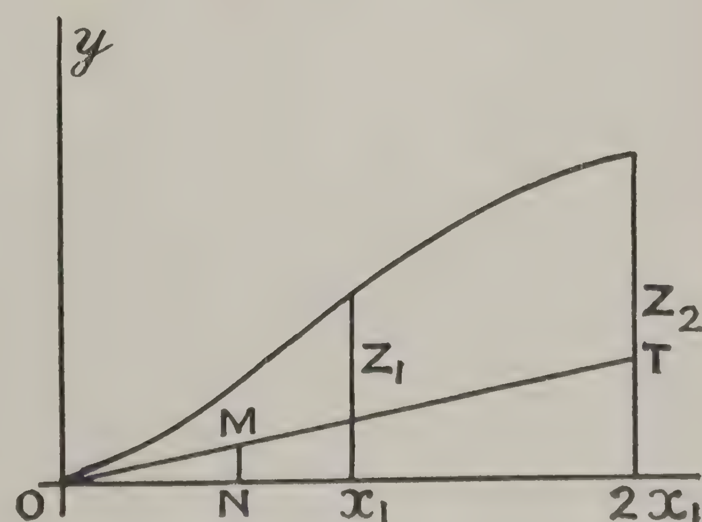

FIG. 4.

then imagine that the molecular constitution of vulcanized rubber is such that the rubber acts during the extension process like a substance whose molecules are formed of a tenacious nucleus of low extensibility and a soft, non-tenacious, highly extensible envelope.

The portion E_o, the initial elongation of the rubber, would correspond to the extension of the enveloping matter alone, in response to slight stress; the middle elongation E_m would correspond to the simultaneous and uneven extension of envelope and nucleus under the increasing stresses and the last elongation, which comes before the breaking point, E_r, would correspond to the very limited deformation of the substance of the nucleus under heavy stresses.

From a practical point of view one sees that the preceding partial elongations are justly characterized by the three constant quantities in the general formula (1).

4. However great may be the scientific value of such results, it seems rather limited *a priori*. We shall show, however, that an essentially practical and altogether rational method of studying rubber may be drawn from them. To do this we need only refer to some already known laws which we have verified over again and to certain new laws which we have established experimentally within certain limits. These laws are as follows :—

1°. The total elongation of a test sample of rubber is proportionate to its initial length l and in inverse ratio to the area s of its transverse section.

2°. The same is true of the initial elongation (constant quantity c).

3°. From the two preceding laws and from the law of extensibility expressed by the equation (1) it appears that the middle elongation (constant quantity a) obeys the previously given law for the total or initial elongation.

4°. The elastic limit elongation (constant quantity b) is independent of the dimensions of the test sample.

5°. The stress for a given elongation is proportional to the section of the test sample; this law extends to the breaking load.

It thus follows from these facts that equation (1) may be transformed into the following one :—

$$y = k\frac{l}{s}x + \propto \frac{l}{s} \sin^2 b\, x \quad (2)$$

in which k and $\propto$ are constant quantities representing the initial and middle elongations and the constant quantity b, which is independent of the dimensions of the test sample, characterizes, as before, the elongation near the breaking point. Therefore we may write, for unit length and section, equation (2) under the form :—

$$y = k\, x + \propto \sin^2 b\, x \quad (3).$$

If equation (1) *is the exact theoretical statement of the law of extensibility, equation* (3) *is its practical expression; for in this formula the constant quantities k, $\propto$ and b depend only upon the nature of the material and serve to characterize it.*

5. The determination of these constant quantities is, moreover, very simple and may be done graphically the following way :—

Take the extensibility curve E (Fig. 4) obtained by points or as recorded by the pencil of a testing machine; draw the tangent to the origin O T; this straight line evidently has for its equation :—

$$y = c\,x.$$

Then, for example : $c = \frac{MN}{ON}$, as measured on the diagram. If the length l and the section s of the test piece have been defined as

$$c = k\,\frac{l}{s}$$

we immediately get :

$$k = c\frac{s}{l} \quad (4).$$

To determine $\propto$ and b, let us consider two ordinates corresponding to the loads x and $2x$, and let us call z_1 and z_2 the portions of ordinates comprised between the tangent O T and the curve, we obtain, then :—

$$z_1 = a \sin^2 b\,x_1$$
$$z_2 = a \sin^2 2\,b\,x_1$$

From these equations we have :—

$$a = \frac{4\,z_1{}^2}{4\,z_1 - z_2} \quad (5)$$

$$\cos^2 b\,x_1 = \frac{z^2}{4\,z_1} \quad (6)$$

Equation (6) gives thus the value of b and as :—

$$a = \propto \frac{l}{s} \quad (7)$$

from the value of a deducted from the equation (5) and brought into equation (7) we deduce :—

$$\propto = a\,\frac{s}{l} \quad (8).$$

6. It now remains to indicate the practical utility of these constant quantities. First of all we shall show that they can be connected with the practical designations used in the rubber industry. These designations which are now somewhat vague, one must confess, will thus have a precise signification.

For instance, the "suppleness" is characterized by its facility of elongation under small loads. We say that the rubber tube that goes on a gas jet without effort is supple.

The suppleness will thus be represented by the coefficient of initial elongation K.

In the same way the "nerve" is the quality which gives the brokers or the buyers their unique mode of judging rubber. If when pulling on this rubber up to the middle extension period one feels a certain resisting power and a great facility to retract, one says this rubber is nervous.

A nervous rubber may thus be characterized by a small middle elongation, that is, by the inverse of the constant quantity $\propto$.

Without forestalling the results of experiments now in the course of execution on hysteresis, and basing our statements solely on facts already given by our predecessors, we can add that nervous rubber will possess great power of retraction. That is, it will return to its initial length in a very short time and will not show a perceptible "permanent set."

The "tenacity" is now generally defined by the breaking-load ; but referring again to the extensibility constants, it is certain that rubber will be the more tenacious the more difficult of elongation it is near its breaking point ; *i.e.*, the constant quantity b will be very small.

Therefore the tenacity may also be characterized by the inverse of constant quantity b of the limit elasticity.

We shall come back a little later to this point and say what is to be understood by soft or firm rubber.

Finally one can also precisely characterize what is so generally and so vaguely called *the elasticity*.

When a boy pulls on a sling, which stretches considerably and returns well when flinging the stone, he says his rubber is very elastic.

The elasticity will thus be characterized by a great elongation at breaking point, that is, by great initial middle and limit elongations of which it is the sum total. The greater the constant quantities k, $\propto$ and b, the more elastic will be the rubber.

It is also almost certain that it must have a great retractive power, and no cycle of surface hysteresis ; in other words, after retraction there should be no permanent set after standing for a short time.

7. Experience shows that the better the rubber (according to the empirical industrial method of judging vulcanized rubber) the higher the constant quantities k and $\propto$ characteristic of the initial and middle elongations, or of the suppleness and nerve. One can therefore classify different vulcanized rubbers in the order of their empirically defined value, from the simple consideration of these two constant quantities.

8. We have studied the variations of the coefficients k, $\propto$ and b under the influence of different causes and we have found in particular that these coefficients vary with the successive tractions undergone by the same test piece. Only after the third pull does vulcanized rubber possess constant elastic qualities. In what follows, the curve of first traction is always meant.

9. The constant quantity b seems generally to increase in proportion with the value of the rubber, but, in defining the value of different rubbers, the definition of this constant quantity does not lead to conclusions as clear as those obtained by the constant quantities k and $\propto$.

It is well known how delicate a problem is the definition of the breaking load x, in kgs. per sq. cm., how much the shape of the test piece, the tightness of the gripping jaws, etc., have to do with the value of this figure, and therefore one need not be surprised to see the elasticity constant near the breaking point (b) markedly influenced. If the piece breaks too soon its breaking load x is necessarily too small and its coefficient b too large ; this nearly always happens with rubber containing much mineral matter. On account of the opposite variation of these two figures b and x one would think that their product, obtained under these unfavourable conditions, would not be far from the true product for the real breaking point, that is, of course, if the anticipated breaking has occurred in the part of the curve which corresponds to the elasticity limit (E_r, Fig. 3). In other words, the product bx would better define rubber with regards to a rational general classification, than the constant quantities b and x taken separately.

This conclusion is confirmed, if one notices that the law of extensibility holds true up to the breaking point, and that the elongation up to the breaking strain y of a test piece of the standard width and section becomes, from formula (1) or (3)

$$y = \mathrm{k}\, x + \propto \sin^2 b\, x \quad (9)$$

The characteristic constant quantities are then k, $\propto$ and bx. Moreover, the preceding formula has an exact physical meaning, which is that the elongation at the breaking point decreases as one goes from good rubber to less and less good qualities.

Experience then shows that product bx takes higher and higher values as the quality of rubber goes down and that thus this constant product allows us to classify rubbers in the same order with regard to their empirical designation as that indicated by the constant quantities k and α. (See table, page 334.)

Note that consideration of this product bx, which is of first importance in the classification of rubbers, shows that rubber is industrially the better, as bx is smaller. Now bx may be small either because b is small (tenacious rubber), or because x is (soft rubber). It is known that soft rubber may be practically converted into tenacious rubber by the addition of mineral matter, for instance; one then increases x and diminishes b; but these opposite actions may still give a larger product bx than that obtained from naturally tenacious rubber. Therefore artificially tenacious vulcanized rubber will be distinguished from naturally tenacious vulcanized rubber by a larger product bx.

In our opinion we may designate as:—

Soft, a slightly vulcanized rubber;

Tenacious, a highly vulcanized rubber;

Firm, a soft rubber made artificially tenacious by the addition of a mineral mixture; unless one prefers to keep the term "firmness" to mean resistance to compression.

10. The preceding conclusion seems to be valid only with regards to rubbers whose elastic qualities differ sufficiently, which is the case with manufactured rubbers.

What happens when one considers the same vulcanized rubber under different conditions, or perhaps, very similar vulcanized rubbers belonging, say, to the class "good rubber" on the preceding classification?

A study of the influence of different factors of vulcanization on the extensibility constant though yet incomplete, allows us to answer this question.

Taking as a basis a standard rubber having extensibility constants fixed by experiment, we may submit all rubber to comparative vulcanization trials, our basis of comparison being a standard rubber which will necessarily be Para.

From an industrial standpoint it appears easy to define with the aid of the extensibility constants, the most favourable conditions of vulcanization for each gum, and thus to define the respective value of each gum in its raw state, but since the vulcanization, *i.e.*, the amount of combined sulphur, at a given time and temperature varies with each rubber, it is a complicated matter to make comparisons between a certain gum and Para, each being vulcanized under *different* best conditions.

To us it has appeared more correct to vulcanize the two rubbers under comparison for the same length of time and at the same temperature. The best according to our work which will shortly be published in full, the best conditions seem to be 3 hours at 140° Centigrade (284° Fahrenheit) for quantities of sulphur varying from 2·5 to 10 per cent.

Vulcanizing, then, under the above conditions, samples of the gum to be studied and comparison samples of Para adding in each case 2·5 per cent. of sulphur, the amount of combined sulphur will vary with the nature of the gum, and this difference in the vulcanization effect (which is not necessarily the best result), will allow us to give the value of a rubber as compared with the other, for the difference is due solely to the nature of the gum which will combine with more or less sulphur according to its natural constitution.

Let us, then, draw the curves of extensibility and deduce from them the extensibility constants. We shall then have the following comparison results for Para as compared with rubber from an Indo-Chinese vine.

	k	α	b	x	bx
Para	0·17	1·4	36·1	10·3	372
Vine rubber	0·21	1·9	55·1	7·6	419

Then, from the connection we have established between the coefficient of extensibility and the technical terms characterizing the rubbers, we may say that the vine rubber is :

$$\frac{0{\cdot}21}{0{\cdot}17} = 1{\cdot}2 \text{ times more supple,}$$

$$\frac{1{\cdot}9}{1{\cdot}4} = 1{\cdot}4 \text{ times less nervous,}$$

$$\frac{55{\cdot}1}{36{\cdot}1} = 1{\cdot}5 \text{ times less tenacious (according to the actual}$$

breaking load 1·4) than the Para.

It may be objected that vulcanization could not be brought about with only 2·5 per cent. sulphur.

We evidently cannot give well defined limitations for a general classification which will require a great number of experiments ; yet we are able to supply in the way of a first indication the following approximate results :—

Nature of the Rubber.	Empirical Trade Designation.	Value of the Coefficients. k.	α	$b \times x$.
Vulcanized natural rubber. No mixture of foreign elements when manufactured.	Very good ..	over 0·20	over 1·1	from 50 to 400
	Good	from 0·30 to 0·05	from 1·1 to 0·2	from 300 to 450
Vulcanized manufactured rubber. Mixed with foreign elements.	Middle class mixed moderately	from 0·10 to 0·03	from 0·2 to 0·1	from 450 to 800
	Very much mixed (bad with regards to extension)	0·05 and under	0·15 and over	over 700

And in fact a more general solution seems to be, not to be contented with a series of tests with 2·5 per cent. of sulphur but to also make one with 5 per cent. and another still with 10 per cent., which will bring out other qualities of the more highly vulcanized rubber. Thus in the chosen instance one would have :

		k	α	b	x	$b \times x$
S = 5% mixed	Para	0·18	0·9	35·2	10·2	359
	Vine	0·20	1·5	30·8	14·5	457
S = 10% mixed	Para	0·10	0·6	27·1	11·2	303
	Vine	0·12	1·0	21·7	18·6	404

which would give the following results, translated into current language, for the qualities of vine rubber compared to those of Para considered as the unit :

	Suppleness.	Nervosity.	Tenacity.
S = 2·5%	1·2	0·7	1·4 to 5
S = 5%	1·1	0·6	1·2 „ 4
S = 10%	1·1	0·6	1·2 „ 6

11. Therefore the method of experimenting for defining the value of a certain rubber consists :

1°. In vulcanizing for 3 hours at 140° C. with mixtures of 2·5 — 5 and 10 per cent of sulphur, the sample of rubber to be studied, also a sample of Para taken as the standard (1).

2°. In tracing the curves of extensibility for these different vulcanized rubbers.

TABLE OF THE CONSTANT QUANTITIES OF EXTENSIBILITY IN TWO PARA SAMPLES FROM DIFFERENT LOCALITIES.

3 hours at 140° C.

	k	$\propto$	b	xr	$c \times xr$	Permanent elongation. (2)	Elongation at breaking Point. (2)
Ceylon Para.							
S mixed = 2·5%	0·17	1·4	36·1	10·3	372	4·0	185
5%	0·18	0·9	35·2	10·2	359	1·2	136
10%	0·10	0·6	27·1	11·2	303	0	93
Amazon Para.							
S mixed = 2·5%	0·32	1·2	43·7	8·7	380	1·0	186
5%	0·18	0·8	40·4	8·6	347	0	120
10%	0·13	0·7	20·9	14·3	299	0	120

3°. In deducing from these the constant quantities in the equation of extensibility.

4°. In finding the ratio between the constant quantities (that is, the numbers which define the technical qualities of the sample) and those obtained with Para.

5°. From these results one can then deduce the value of the rubber in its raw state.

There being a large number of Para varieties the question arises as to which standard would be the best to adopt.

We have found that two Paras, one from the Amazon, the other from Ceylon, do not differ much the one from the other (see above Table), under conditions as previously indicated, but this point can only be settled by a series of systematical experiments.

It appears to us that the rubber industry would profit by the creation of such a standard and the application of a comparative method similar to the preceding one; also that the producer would equally benefit a lot from a simple and rational method of establishing the practical value of the rubber. It is with this utilitarian purpose in view that we lay before the International Rubber Congress a summary of a part of our studies on rubber now undertaken in the rubber research service of the Colonial Department.

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(1) The Para values could evidently be fixed once for all, but the simultaneous vulcanization of the Para and the rubber under comparison naturally tends to avoid mistakes.

(2) These permanent sets and breaking point elongations are given in terms of the observed elongations Ap, and Ar, the length l, and the section s of the test sample in the formula:

$$Qp = Ap \times \frac{s}{l} \times 100$$

$$Qr = Ar \times \frac{s}{l} \times 100$$

The Oxidation of Sulphur by Nitric Acid.

By H. E. POTTS, M.Sc.

This fundamental operation in rubber analysis has naturally attracted much attention. Although statements have been made that losses may occur (cf. Wagner, Sautter, etc.†), the conditions under which these losses take place, and the amount, do not appear to be generally known. The author has been obliged to investigate the subject for the purposes of his own work, and although it was found, when these experiments had been practically concluded, that Bertrand* had arrived at the conclusion that SO_2 could be lost, when oxidising with nitric acid in an open flask, yet it appears worth while to give these results, which embody collected information on a disputed point. It may be added that, as the experiments show, the errors which are possible may be instinctively avoided in very many cases.

The aim of the investigation, then, was to determine the conditions under which losses occurred. Incidentally, a number of questions concerning the precipitation of barium sulphate were involved, and finally the volumetric method, of Fresenius and others, has been examined from the point of view of rubber analyses.

I. The question of the *gravimetric estimation* of sulphuric acid naturally comes first. The extensive researches which have appeared under this head have been mainly concerned with large precipitates, such as those met with in pyrites analysis (1.7 gms. $BaSO_4$). The valuable and exhaustive paper of Allen and Johnston† deals with the subject in a very comprehensive manner. They showed that to obtain accurate results, it was necessary to add the barium chloride drop by drop, and to apply a number of corrections for solubility, occluded salts and free sulphuric acid in the precipitate. They also remark, however, that the method of rapid precipitation of Hintz and Weber yields a very good uncorrected result.

In the case of sulphur estimations in rubber it is not always easy to apply this method, since the number of cc. barium chloride required may not be accurately known. If such accuracy is required, it is recom-

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*Abstr., Jahrbuch der Kautschuk Industrie, 1909, p. 353.

† Jour. Amer. Chem. Soc., 1910, 32, 588.

mended that an aliquot part should be titrated, and that, knowing the approximate strength, an excess of about 2 cc. 10 per cent. barium chloride be used (the whole diluted with 4 times as much water, and added boiling, at once). Nitrates must, of course, be completely removed in this case.

For many purposes, however, such accuracy is not essential. A number of estimations were accordingly made of pure sulphuric acid, to which varying amounts of salts were added, in order to determine the loss of barium sulphate in comparatively small precipitates. Here also statements have appeared in the literature which lead to the conclusion that serious losses may occur.* The barium chloride was added (excess about 2 cc.) in 10 per cent. solution from a burette, dropping the liquid down the sides of the beaker so fast that drops were just formed. The amount of free acid was made throughout equal to 1-2 cc. conc. HCl. Taking sulphuric acid approximately $\frac{N}{10}$, the precipitate found after standing about 2 hrs. (volume 200 cc.) was :—

cc. taken.	Acid + 10 gms. KCl	Acid alone.	Acid + 4 gms. KCl + 1 gm. KNO_3.
10	.01131	.01165	.01187
25	.01140 × 2.5	—	—
50	—	.01160 × 5	—
100	.01147 × 10	.01163 × 10	.01157 × 10

Expressed as percentage of sulphur on 1 gm. rubber :—

S	Effect of 10 gms. KCl	Effect of 4 gms. KCl + 1 gm. KNO_3.
1.6%	— .05%	+ .03%
4.0%	— .07%	—
16.0%	— .23%	— .08%

For many purposes, these errors would not be serious, especially since they represent maxima. In many sulphur estimations less than 10 gms. of salts are present, and a small quantity of nitrate which may not be removed will raise the results.

To show the effect of the actual salts produced in an estimation, the thick syrup formed by evaporation of ½ gm. Para with 15 cc. nitric acid was ignited fairly rapidly with 5 gms. of the usual fusion mixture. The mass was evaporated to dryness with 20 cc. conc. HCl (small volume for rapidity—also more HCl_5 would give a worse result, since it would remove more nitric acid). After acidification with cc. dil. HCl and addition of water, the liquid was filtered. Three blanks in this way gave .0044, .0049, .0057 $BaSO_4$, mean = .005. To liquids prepared in this way (of volumes 200–400 cc., the results being similar in either case) known amounts of sulphuric acid were added. After precipitating with barium chloride rapidly drop by drop, and standing only ½–1 hr., for rapidity, the following results were obtained (deducting .005 for blank) :—

* Hübener, Gummi Zeit., 1909, 24, 213.

$BaSO_4$ calc.	Found.	Error.	Error as % S on 1 gm. rubber.
.116	.109	.007	— 0.10 on 1.6%
.290	.288	.002	— 0.03 on 4.0%
.580	{ .576, .577 / .578, .579	mean .002	— 0.03 on 8.0 %
1.161	1.152	.009	— 0.13 on 16%

The results are not much better when the ppt. stands over night, though this is advisable for small ppts.

Folin* estimates sulphuric acid in the presence of nitrates + an excess of chlorides. As Ruppin has pointed out, among others, the accuracy of a determination of sulphuric acid essentially depends on the degree to which the various known errors are made to compensate one another. Since in rubber analysis nitrates are very frequently present, it would seem that here was a very effective method of dealing with the error caused by chlorides. This could be done by evaporation with HNO_3 after fusion and then adding chlorides to the fourfold amount. It is well known that nitrates raise the result, and thus if the amount of nitrate present is known, a very fair compensation can be effected. The proportion of 4 KCl : 1 KNO_3 is very effective in this connection. As shown above, this ratio gives fairly good results with varying weights of precipitate. Naturally the degree of compensation depends on the weight of precipitate, but it was found that under the following conditions

Acidity = 1 cc. conc. HCl. Volume = 200 cc. 8 gms. KCl + 2 gms KNO_3.
Precipitate with 10 cc. 10% barium chloride. Let stand over night.
Weight of precipitate = about 0.7 gms.

very accurate results were obtained. When the estimations of sulphuric acid were made under the above conditions, against two of sulphuric acid alone (precipitated by diluter barium chloride, drop by drop—the results are good under these conditions, vide Richards and Parker†), the four precipitates were not different by more than 1 milligram in .7 gms.

Under the above conditions, the compensation is perfect, and it appears generally that a mixture of nitrates : chlorides in ratio 1 : 4 will yield a closer result (uncorrected) than chlorides alone, when precipitating drop by drop. Gill and Grindley‡ confirm this conclusion.

II. The process of Fresenius and others, for the *volumetric estimation of sulphates*, by direct titration with barium chloride, has been found to be useful. $\frac{N}{16}$ barium chloride was used, so that 1 cc. = .001 S = 0.1 per cent. on 1 gm. rubber. A solution was made up to this normality from crystallised barium chloride. Gravimetrically the barium solution was $\frac{N}{16} \times 1.006$. Titrated against a solution of sulphuric acid which had been estimated gravimetrically, it yielded an identical value.

The estimation was performed by boiling the liquid (volume 100 cc.), adding 90 per cent. of the calculated quantity of barium chloride from the burette as rapidly as possible, and then testing small portions removed by a Beale's filter. The liquid was spotted on a mirror and tested with both barium chloride and sulphuric acid. Sutton ("Volumetric Analysis") recommends adding barium chloride till a precipitate is no longer yielded

* Chem. Zentr., 1906 (I.), 872.
† Zeit. Anorg. Chem., 1895, 8, 413.
‡ Jour. Amer. Chem. Soc., 1909, 31, 352.

with barium chloride on the mirror. It was found easier to titrate till the opalescences obtained with barium chloride and sulphuric acid were equal. This method is better also since the end point is less shifted by presence of acid etc., though it is less sensitive then. The acidity ought not to exceed 0.4 cc. conc. HCl in 100 cc., otherwise the end-point is not good. If the amount of acid is kept low, and nitrates are not present without chlorides also, the end-point is good to about 0.3 c.c. = 0.03% S on 1 gm. Under these conditions the filtration does not present difficulties, and even if a trace does happen to run through, the appearance is quite distinct from the opalescence produced by addition of barium chloride or sulphuric acid. The effect of salts is shown in the following :—

	$BaCl_2$ used.	%S found.	%S taken.
1. 25 cc. of sulphuric acid (solution A) alone	39.1	3.93%	3.95%
2. 25 cc. solution A + 1 gm. $NaNO_3$ (bad end-point)	39.5	3.97%	3.95%
3. 25 cc. solution A + KCl + NaCl (equiv. to 5 gms. fusion mixture)	38.5	3.87%	3.95%
4. 25 cc. solution B (sulphuric acid alone) ..	19.8	1.99%	1.96%
5. 25 cc. solution B + KCl + NaCl as above ..	19	1.91%	1.96%
6. 25 cc. solution B + KCl + NaCl as above + 1 gm. $NaNO_3$	19.7	1.98%	1.96%
7. 5 cc. solution A alone	8	.80%	.79%
8. 2½ cc. solution A + KCl + NaCl as above. (Two titrations done, as first gave bad end-point)	3.8	.38%	.39%
9. 2½ cc. solution A alone	4.1	.41%	.39%

It will be seen that the effect of salts in ordinary amounts (corresponding to 5 gms. fusion mixture) is to introduce an error up to about 0.05% on 1 gm. If nitrate is present, about double the amount of chloride is added, when the result is not affected materially.

As it is advisable to keep the volume small, there is possibility of loss by the amount taken for the spotting, hence with an absolutely unknown solution it may be advisable to do a rough test first, so that about 90 per cent. can be added at once.

In the determination of free sulphur, the liquid can be made up to 250 cc. and 100 cc. taken. With 5 gms. extracted, this corresponds to 2 gms. rubber. Hence percentages of free sulphur from 0.5 to 2.5 will require from 10 to 50 cc. barium chloride ; each 1 cc. = 0.05% ; the titrations will agree to about 0.01–0.02%, while the error caused by salts will be 0.03%, or less since salts are not present in large amount.

III. *Volatility of sulphuric acid* was a possible factor, and as variable results were obtained in about 15 experiments in which sulphur was oxidised by nitric acid, some experiments were made to determine the extent of the loss of sulphuric acid, if any.

1. In evaporation of solutions of sulphates + chlorides + hydrochloric acid.

50 cc. of sulphuric acid were taken in each case. The volume was the same in all the estimations, as was the acidity and amount of barium chloride added (8 cc. 10%). The precipitate was allowed to stand for about 2 hours before filtration.

(*a*) + 2 gms. KCl. gave .5717 and .5717 gms. $BaSO_4$
mean = .5717

(*b*) + 2 gms. KCl. Evaporated to dryness in water-bath, added 50 cc. conc. HCl, evaporated to dryness. Took up with 5 cc. dilute HCl. and water. .5724 and .5720
mean = .5722

(*c*) + 2 gms. KCl. Treated as *b*, but on hot plate instead of water-bath. .5712 and .5729 mean = .5721

Evidently no loss has occurred here, though this would scarcely be expected.

2. In evaporation of sulphuric acid in presence of nitric acid without salts. (*a*) Volumetric estimation.

(1)	25 cc. sulphuric acid solution reqd.	39.1 $BaCl_2$
(2)	The same, evaporated to syrup in water-bath for 20 minutes	39.4 $BaCl_2$
(3)	As (2) for 40 mins.	39.2
(4)	25 cc. sulphuric acid solution + 1 KNO_3 + 2 KCl ..	38.8
(5)	25 cc. sulphuric, evap. in water-bath, 25 cc. nitric acid added, again evaporated. Then 1 gm. KNO_3 added and evaporated, took up with water, added 2 cc. dil. HCl + 2 gms. KCl	38.8
(6)		38.5
(7)	As (5), (6), but 25 cc. fuming nitric acid added instead of ordinary nitric acid	38.7
(8)		38.5

Here again no appreciable loss is found. This was verified by gravimetric work.

(*b*) (1)	50 cc. sulphuric alone	.5771 $BaSO_4$
(2)	50 cc. sulphuric evaporated to syrup in water-bath (1½ hrs.)	.5752
(3)	50 cc. sulphuric + 2 gms. KNO_3 (acidity + 1 cc. conc. HCl) + 8 gms. KCl.	.5766
(4)	50 cc. sulphuric acid evaporated in water-bath to a syrup, then repeated with addition of 50 cc. fuming nitric acid (Δ 1.5). Added 2 gms. KNO_3 and water, evaporated to dryness and precipitated (+ 8 gms. KCl) as in (3).. ..	.5783
(5)	As (4) using 50 cc. ordinary nitric acid (Δ 1.42) instead of fuming acid	.5782

The conclusion is thus confirmed that sulphuric acid is at all events only very slightly volatile when evaporated with nitric acid ($\triangle$ 1.4 or 1.5), placed in a beaker in a boiling water-bath for about 3–4 hrs. in all. (The slightly higher result in (4) and (5) may be due to traces of silica dissolved from the glass).*

IV. The *oxidation of sulphur by nitric acid* (*fuming*, Δ 1.5) was then investigated in the light of the conclusion above, that sulphuric acid is practically non-volatile on the water-bath.

High quality sulphur, such as is used in rubber works, was used. There was no loss in weight on leaving for 2 days in vacuo over sulphuric acid.

0.1000 gms. were weighed out into a large beaker (this, of course, gives the greatest opportunity for losses) covered with a clock glass,

* Further experiments on the evaporation of sulphuric acid alone, made in conjunction with Mr. J. S. Thomas, showed that slight losses seem to occur within the above limits. These, of course, do not materially affect analysis, but we are investigating the matter further.

20 cc. fuming nitric acid were added, and the beaker heated, either placed on top of a boiling water-bath, or placed half in the water itself.

After oxidation was complete, 2 gms. KNO_3 were added, the cover-glass and sides of the beaker were rinsed with water, and the liquid evaporated to dryness in the water-bath. 8 gms. KCl + 5 cc. dilute HCl were added, and the volume made up to 200 cc. Precipitation was effected with 10 cc. 10 per cent. barium chloride added rapidly drop by drop, and the precipitate was allowed to stand over-night. Under these conditions, as shown above, a correct result is obtained for the weight of precipitate in question.

The following results were obtained :—

1.	Beaker on water-bath ..	.7154 $BaSO_4$	= 98.2%
2.	As (1) another experiment	.7194	= 98.8%
3.	Beaker *in* water-bath ..	.6509	= 89.4%
4.	As (3) another experiment	.6369	= 87.5%
5.	Beaker *on* water-bath* ..	.7172	= 98.5%
6.	KNO_3 added at beginning	.7124	= 97.8%

*Two separate experiments.

The action was very energetic in (3) and (4), and it is fairly clear that the loss is due to too high a temperature *during oxidation*, which probably causes loss of SO_2. The effect of addition of KNO_3 does not appear material, but it seems an advisable precaution, since, as it dissolves in the acid, it tends to moderate the action. Further experiments confirmed this marked difference between oxidation with the beaker placed on the water bath and placed in the water itself. With 0.25 gms. sulphur, of which 100/250 was taken for the gravimetric estimation, it was found that while 96.5 per cent. was obtained when the beaker was on the water-bath, only 90.4 per cent. was obtained when the beaker was in the water-bath. A similar result was obtained with 0.1 gms. sulphur which was oxidised, and then $\frac{2}{5}$ of the amount estimated volumetrically. The oxidation conducted on the water-bath gave 95.6 per cent., while in the water-bath the result was 90·0 per cent.

Two estimations of .08 and .15 gms. of sulphur carried out still more slowly on the water-bath (not heating by steam direct but interposing a clock glass) gave results of 98.7 and 100.1 per cent.

Thus in all cases when the oxidation is performed *on* the water-bath a considerably higher result is obtained. If the beaker is placed *in* the water-bath losses up to $12\frac{1}{2}$ per cent. can occur during the oxidation itself. It is evident that in sulphur estimations the most extreme and even meticulous care should be exercised at this stage of the operation : what occurs afterwards is really of subsidiary importance. Consequently the action of fuming nitric acid in a free sulphur estimation, which is liable to be violent on account of the presence of resin, should be moderated as much as possible, till all particles of sulphur have disappeared.

It may be added that in actual estimations of total sulphur, the errors may be smaller than those observed above, since the sulphur is distributed throughout the rubber.

The loss can be avoided by heating in a sealed tube to 100° till all free sulphur has disappeared, and then evaporating down in the water-bath with a salt.

Two estimations were done in which 0.1006 and 0.1014 gm. sulphur were taken. After heating for about 3 hrs. and 1 hr. respectively, with 10-20 cc. fuming nitric acid in a sealed tube in the water-bath, the acid was washed into beakers, and evaporated in the usual way. Results were obtained of 101.0 per cent. and 100.1 per cent. The high result is probably

due to silica from the tube, since it occurs in that which was heated 3 hrs. (cf. Anelli,* who found that in the Carius method the results were 2–4 per cent. too high. In this case, however, heating was only done at 100°).

SUMMARY.

I. The precipitation of barium sulphate in presence of nitrates and chlorides in ratio 1:4 is recommended as giving better uncorrected results than those in presence of chlorides alone.

II. The volumetric method of direct titration with barium chloride has been examined under the conditions occurring in rubber analysis. The results are sufficiently accurate for many purposes.

III. Sulphuric acid is shown to be almost non-volatile on the water-bath under ordinary conditions.

IV. The oxidation of sulphur by fuming nitric acid is liable to very serious losses, unless carried out very gently. The loss can be avoided by heating at 100° in a sealed tube until the free sulphur has disappeared.

I must thank my assistant, Mr. C. Wilkinson, who has materially aided me, especially with the volumetric work.

The CHAIRMAN: We must compliment Mr. Potts on his excellent paper. It is now open for discussion.

Dr. STEVENS: I think we are all extremely indebted to Mr. Potts for the work he has carried out. It is hardly possible to over-estimate the importance of having a reliable method which can be used, which will not take too long, which can be done within a reasonable time in the laboratory, and on which we can depend, in estimating sulphur in vulcanised rubber articles. The paper is so full of detail, and so many points have been raised, that in the short time at my disposal it is impossible to discuss them in detail. I should like to ask if the lecturer has any figures of the loss which I understand may be 12½ per cent.?

Mr. POTTS: I found 89.4 and 87.5 per cent. in two experiments, the beaker inside the water-bath.

Dr. STEVENS: Did you give the figure for the loss where you placed the dish, or the beaker, on the top of the water-bath?

Mr. POTTS: On the top of the water-bath I found 98.2 per cent. and 98.8 per cent., but I got rather higher by interposing a clock glass to intercept the steam.

Dr. STEVENS: So that we may reckon all the published determinations of free sulphur are 2 per cent. too low?

Mr. POTTS: I do not think so necessarily if it is done very carefully, as many analysts would do instinctively. I have got up to 99.5 per cent.

Dr. STEVENS: One other point. With regard to 1 materially took. I understand you took the raw rubber and treated it with nitric acid and sulphur. I did not follow what the material taken in this experiment was exactly.

Mr. POTTS: When I took half a gramme of Para, that was to determine the conditions of precipitation. I took it as a blank, to find out how much sulphur would be lost under ordinary conditions of precipitation. In the experiments on loss during oxidation, I worked on pure sulphur alone.

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* Gazzetta Chim. Italiana, 1911.

Mr. BEADLE : I take it this was not done on various rubber mixtures but only on pure Para, where the question of the exact amount of sulphur present is of considerable importance. How would the presence of other mineral matters, resins and various substitutes, affect the question of the examination of the sulphur ? Another point is the oxidation of the sulphur by nitric acid. Was loss of sulphur due to formation of SO_2 which came away as gas ?

The CHAIRMAN : He suggested a mechanical removal in the form of a minute spray as the probable reason of the loss of sulphur.

Mr. POTTS : I did not use vulcanised rubber at all ; I merely used Para rubber. In the losses from sulphur I worked on pure sulphur without any rubber. I agree as to the SO_2, though I did not prove that SO_2 was evolved. If one conducts the estimation very slowly, one can get it so that it does not bubble very much. The thing to aim at is that the top of the vessel is not full of brown fumes. You referred to the use of salts. Some say potassium nitrate diminishes the effect. It does dissolve in fuming nitric ; but with 2 grammes of nitrate present I found 98.5 per cent. and 97.8 per cent., which was not very different from the results obtained without the presence of potassium nitrate, though it might be an advisable precaution, as tending to moderate the action.

The CHAIRMAN : I would like to ask Mr. Potts whether he has any direct evidence as to the loss being due to sulphur dioxide ?

Mr. POTTS : No.

The CHAIRMAN : I feel inclined to doubt it unless there is some direct evidence. Stas found that it was necessary to use either an autoclave or a flask with delivery tube provided with washing bulbs in order to avoid loss of silver—when the silver was being dissolved in nitric acid. When iron is dissolved in moderately strong hydrochloric acid, there is considerable loss of both iron and chlorine unless similar precautions are taken. There are so many such cases that it appears to me more probable that the loss in this case is a purely mechanical transference (by spray) of sulphuric acid which could be obviated by the introduction of washing bulbs nearly, if not quite, as effectively as by performing the oxidation in a sealed tube.

Mr. POTTS : I will test that point.

In reply to another question by Miss Borrowman, Mr. POTTS said : These investigations were conducted on pure sulphur alone, but as it was necessary to estimate them accurately, the behaviour of various salts in the precipitation was investigated, and as bearing on the determination of total sulphur, a number of estimations were made in order to study the effect of the mixture of chloride and nitrate produced by the evaporation with HCl of the salts produced by fusion. These salts resulted by the ignition of the fusion mixture with the syrupy product from Para and nitric acid, and are not similar in composition to fusion mixture, so that actual trial of their effect on the precipitation is necessary.

Impact-Tensile Tests on Rubber and a Comparison with Tensile and Hysteresis Tests.

By CLAYTON BEADLE and HENRY P. STEVENS.

THE Impact method of testing is recognised as applied to materials such as steel*, and it occurred to one of us that this type of test could be usefully applied to vulcanised rubber, such as compounded rubbers of the type of mechanicals, where the conditions to which the rubber is subjected in daily use expose it to sudden strains and stresses. Take, for instance, the case of a tyre—especially a solid tyre—meeting an obstacle in the road. In such a case the rubber compound is subjected to a sudden jar, quite unlike the gradually increasing stress put upon it for ordinary tensile strength determinations.

A few remarks upon various types of machines which so far have not been considered in connection with testing properties of rubber would not, we think, be out of place here, especially as these types have led up to the use of the machine later to be described.

The principle of drop testing, we think, might with advantage be developed for certain kinds of rubber goods. On these lines for other materials an instrument called the Schlerescope has been devised by A. F. Shore, an American, an illustrated description of which is given in the "American Machinist" (Vol. xxx, part 2, page 747). This instrument consists of a steel ball enclosed in a glass tube from which it is released by opening a small shutter with a rubber bulb, in the same manner as the shutter of a photographic camera is operated. The hardness of the material is measured in the rebound of the ball falling upon it from different heights. We think that an instrument on these lines might be found of considerable service in recording some useful qualities of certain classes of rubber goods. This test has, of course, nothing to do with fracture or strength.

For the purpose of determining "work done," some experimenters allow a falling weight to break the specimen (Stanton's method is an instance), and measured the unabsorbed energy by testing the degree of impression of a spring upon which the weight falls, after breaking the specimen. Others, Kirkaldy, for example, also use a falling weight but measure its acceleration both before and after breakage. It is obvious that such a principle would not be applicable to soft unbreakable goods by merely falling *upon* the specimen, but can be used to fracture a strip fixed at one end and attached to the weight by the other.

This leads us up to the impact testing machine on the pendulum principle. The only type we know of on the market in this country is the machine made by Avery of Birmingham (Izod's patent). We have

* Comparison of the Tensile, Impact-Tensile, and Repeated-Bending methods of testing Sheet-Blount, Kirkaldy and Sankey. Inst. Mech. Engineers, May, 1910, page 715.

tried this with a view to adapting it to rubber and found it to be quite unsuitable. It is constructed for quite another purpose. This and others sold of a somewhat similar nature may be described as shearing and bending-impact machines. Izod supports a short specimen of metal to be tested, rigidly and vertically in a vice. A notch is made just above the jaw of the vice, and a pendulum is caused to hit the top of the specimen, breaking the top off. The energy absorbed in breaking is measured by the difference in height to which the pendulum rises both before and after the operation.

At the Congress of the International Association of the Standardisation of the methods of testing materials of construction, held at Brussels in 1906, the impact test was fully considered and the one blow impact test with notched specimen was adopted.

Mr. J. H. Lester was, as far as we know, the first to measure the tensile strength by means of a pendulum in terms of the "Work done" (first described in a paper on "Scientific Instruments for Testing Textiles" read before the Annual Congress of the Textile Institute, held at Bradford in September, 1910). Mr. Sheldon Leicester, of London, is, we believe, applying the same principle to the testing of paper or conducting researches with this object in view.

We have recently constructed a modified type of machine very much on the lines of Lester's impact-tensile machine for textiles, which we have used in conjunction with other tests for rubber.

With the assistance of Mr. G. C. Lloyd, the secretary of the Iron and Steel Institute, we have made enquiries as to the acceptance of this test and find that in England it is not much accepted, although considerable use is made of it on the Continent.

In devising a suitable machine, the principle of the falling weight lends itself in one or two ways. Either, as above shown, the weight may be allowed to fall in a free path, or the path may be controlled as in the swing of a pendulum. We decided that the pendulum form of apparatus would be the simplest for our purpose. Our pendulum consists of a mass of metal weighing 500 grams., suspended by means of a light steel wire, the upper part of which is fixed to a barrel with recesses parallel to the axis to take the points of two screws between which it swings. This gives a practically frictionless form of suspension which is less easily thrown out of gear than an ordinary knife edge, or arrangement first suggested by Lester, which consisted of a cross pin attachment suspended between two pairs of intersecting wheels or discs. In working this machine the pendulum is held up to one side and at the bottom of the fall ruptures the rubber test piece, thus losing part of the potential energy gained by the height through which it has fallen. The energy remaining, carries the pendulum a certian distance up on the other side of the stroke, the highest point reached being indicated by an adjustable pointer, as used by Avery's and others', which the pendulum strikes after breaking the rubber, and carries with it as it moves upwards. The difference between the height from which the pendulum was originally allowed to fall and the height to which it rises is a measure of the energy required to break the rubber test piece, and is simply expressed by the following equation :—Energy absorbed $= W (H - H^{\circ})$ where W is the weight of the pendulum (in this case 500 grams) and H is the height from which the pendulum was allowed to fall and H° the height to which it rises at the end of the swing.

As in other forms of rubber testing machines where the tension applied to the test piece is carried to breaking point, there is considerable difficulty in devising a suitable form of test piece. We have, however, found that we could adapt the small ring test pieces such as we use for our tensile testing machine (" Journ. Soc. Chem. Ind., 1909, p. 1,111 "). A hook is attached to the weight and a similar hook to a flexible cord of a material which will not stretch. The ring test piece is slipped over the hooks and the end of the cord is kept fixed in such a position that the strain is put on the test piece just at the moment the weight reaches the bottom of its path and is moving with the maximum velocity. The cord must be sufficiently long to allow of the pendulum being raised to the necessary height while the test piece is in position.

A second hook is fixed to the weight, which is raised and adjusted to the position from which it is intended to allow it to fall by means of a piece of cotton. The end of the cotton may be clamped with the pendulum in the raised position, and, by cutting the cotton with a razor, the weight falls freely. We have tried a trigger release but have not found it to be an advantage. The pendulum is hung in front of a board on which is a scale divided vertically into centimetres. Then, having the weight of the pendulum 500 grams, we obtain at once the energy absorbed in rupturing the test piece according to the formula given, expressed in terms of gram centimetres.

We find it convenient not to raise the weight more than about half of the quadrant—Avery's machine is constructed to release at half quadrant as maximum. Lester found with textiles that, if a large proportion of the energy stored up in the raised weight is absorbed by the break there is a " nasty jar " produced and the results vitiated. We are inclined to confirm this, but perhaps with an elastic substance like rubber this is not so noticeable.

The samples tested were made up according to the following formulæ :—

Sample.	Rubber.	Sulphur.	Zinc Oxide.	Magnesia.
A	95·24	4·76	—	–
B	90	4·5	5·5	–
C	85	4·25	10·75	–
D	70	3·5	26·5	–
E	60	3	37	–
F	60	3	36	1
G	60	3	35	2
H	60	3	34	3

It will be seen that these rubbers all contained 5 per cent. of sulphur reckoned on the rubber, the remainder being mineral. Sample A contained no mineral matter, samples B to E increasing proportions of zinc oxide, samples F. G and H were identical with sample E except that 1, 2 and 3 per cent. of zinc oxide were respectively replaced by magnesia in samples F. G and H. Except, then, for the introduction of small percentages of magnesia, the samples E to H contained the same proportions of rubber, sulphur and mineral.

The results obtained with a series of eight vulcanised compounds are given in the table below against their composition.

Rows 1 to 4 give Composition.
,, 5 ,, 7 ,, Impact Tensile Tests.
,, 8 ,, 10 ,, Tensile Tests.
,, 11 ,, 13 ,, Hysteresis Tests.

To enable an interpretation to be put upon rows 5, 6 and 7, we have tested the same compounds in other ways. Thus the row 8 gives the breaking strain in grams per sq. mm. cross sectional area, row 9 gives the extension at the moment of rupture, taking the original length equal to 1, whilst row 10 gives the product of the breaking strain and extension—that is to say, the breaking strain per sq. mm. cross sectional area of the sample when at full the extension.

Following these we give a series of hysteresis tests on the same rubbers. The row 11 gives the extension with a load of 200 grams per sq. mm., the row 12 gives the "cyclic remainder" or sub-permanent set, while the row 13 gives the "cyclic fatigue." These latter terms have been fully explained in another paper before this Conference, entitled "Raw Rubber Testing."

TABLE OF PHYSICAL TESTS.

	A.	B.	C.	D.	E.	F.	G.	H.
1. Rubber ..	95·24	90·0	85·0	70·0	60·0	60·0	60·0	60·0
2. Sulphur ..	4·76	4·5	4·25	3·5	3·0	3·0	3·0	3·0
3. Zinc Oxide ..	—	5·5	10·75	26·5	37·0	36·0	35·0	34·0
4. Magnesia ..	—	—	—	—	—	1·0	2·0	3·0
5. Impact Tensile mean of 1st 5 tests	11700	13900	13500	13750	13700	15250	11500	—
6. Impact Tensile mean of 2nd 5 tests	11950	14000	13300	14050	14100	14750	11500	—
7. Impact Tensile mean of all tests	11820	13950	13400	13900	13900	15000	11500	—
Tensile								
8. Breaking strain	285	433	431	422	330	503	517	567
9. Extension at breaking point	10·8	9·2	8·9	8·1	6·9	6·7	6·5	6·2
10. Breaking strain (per sq. mm. cross sectional area), at full extension	3078	3984	3836	3418	2277	3370	3361	3515
Hysteresis.								
11. "Extension 1st cycle" with constant load ..	578	382	345	292	275	140	107	75
12. "Cyclic remainder" (or sub-permanent set after completion of 5th cycle) ..	34·0	13·6	13·6	14·4	18·4	6·8	5·6	4·4
13. "Cyclic Fatigue"	14·8	6·6	9·5	11·3	14·2	2·7	2·1	1·1

The limits of variation as calculated from the impact-tensile tests figures are as follows :—

TABLE SHOWING LIMITS OF VARIATION WITH IMPACT TENSILE TESTS.

Sample.	Plus or minus variations from mean of 10 tests.	Limits of variation between duplicate sets of 5 tests.
A	+1·0%	2·0%
B	±0·4%.	0·8%
C	+0·8%	1·6%
D	±1·1%	2·2%
E	±1·5%	3·0%
F	±1·7%	3·4%
G	0·0%	0·0%
H	—	—

The above figures show that the limits of variation between duplicate sets of five tests is exceedingly small.

We have divided Lester's results with Textiles into groups and similarly calculated them to determine the "limits of variation," and find that his figure is very similar to our own. His results also accord fairly closely with figures got from "stress and strains" diagrams.

CONCLUSIONS.—*Impact-Tensile Figures.*—On examination of the impact-tensile figures we find that the introduction of zinc oxide causes a very considerable rise for the first 5 per cent. or less, as shown by comparing A and B, but on the addition of further zinc oxide, *i.e.*, from 5 per cent. to 37 per cent. (except in the case of C), the figures are almost identical. Then, on the addition of 1 per cent. of magnesia, the impact-tensile test is largely increased (F), but diminishes again to as low a figure as the unloaded specimen when the magnesia is 2 per cent. (G). These results only tend to record by tests what is already known in practice, namely, that small quantities of these substances produce marked changes in physical qualities. It also appears that, from the point of view of these tests, larger quantities of these minerals act as so much loading matter.

Tensile Strength Tests.—These figures show that it is only the first 5 per cent. or less of added zinc oxide (B) that is effective in giving increased breaking strain, after which up to 26 per cent. the breaking strain remains practically constant, and that a further 10 per cent. (E) on the top of 26 per cent. results in a decreased breaking strain. Furthermore that the addition of such small quantities as 1 per cent. to 3 per cent. of magnesia on top of the other mineral matter largely increases the breaking strain, even to the extent of doubling the original strength as compared with the unloaded sample.

Comparing the "Impact-Tensile" with the tensile figures, we find, that the introduction of zinc oxide results in both in higher figures, although the tendency is to drop slightly from sample B onwards. The introduction of one part of magnesia in both produces an increase in the figure, but further additions of magnesia cause slight further increases in breaking strain and not decreases, as in the case of the impact-tensile results. Substantially the same results are in a measure obtained if we take the figures in the row 10 in which an allowance is made for the amount of extension at the moment of rupture.

Hysteresis figures show that there is an increased resistance to stretching with increasing proportions of zinc oxide. This increase is much more rapid with small additions—the more zinc oxide added the less the added effect produced. Coming now to the magnesia compounded rubbers, these show further increased resistance, each 1 per cent. of magnesia producing a less effect than the preceding 1 per cent.

The "cyclic remainder" figures at first show considerable diminution but with larger proportions of zinc oxide the figure tends to increase again. The same applies to the figures for cyclic fatigue.

It will be seen, then, that Impact-Tensile results do not fall exactly into line with any of the other tests. They show the greatest difference in the magnesia compounded rubbers for, while 2 and 3 per cent. of magnesia increases the tensile strength and show improved figures in most of the other tests, we have in the case of the Impact-Tensile tests a considerable falling off in values.

These remarks may perhaps be better understood by reference to the following table :—

TABLE SHOWING THE CHANGE IN VARIOUS PHYSICAL QUALITIES AS THE RESULT OF ADDED MINERALS WHEN A = 100.

Sample	Added Minerals. Zinc Oxide.	Magnesia.	Impact Tensile.	Tensile Strength.	Elongation at Break.	Breaking Strain at Full Extension.	Extension 1st Cycle with Constant Load.	Cyclic Remainder.	Cyclic Fatigue.
A ..	0·0	—	100	100	100	100	100	100	100
B ..	5·5	—	118	152	85	129	66	40	44
C ..	10·75	—	113	151	82	125	60	40	64
D ..	26·5	—	118	148	75	111	50	42	77
E ..	37·0	—	118	116	64	74	47	54	97
F ..	36·0	1	127	176	62	110	24	20	17
G ..	35·0	2	98	181	60	109	19	16	14
H ..	34·0	3	—	199	57	114	13	13	8

We bring the results of impact tensile test forward in the belief that this method of testing will be found to have considerable value when sufficient comparisons have been made on samples of known manufacture to enable us to put a proper interpretation upon the results.

The CHAIRMAN : This paper opens up a new method of testing. We all know the fine results of testing steel by the impact or ballistic test and I hope there will be a good discussion.

Dr. STEVENS : Having been associated with Mr. Beadle in carrying out the tests there are possibly one or two points to which I may allude, particularly with regard to the effect of adding small quantities of magnesia. As is well known, magnesia, even in small proportions, as little as a half per cent. or so, increases the tensile strength of the rubber, but we find, when we come to examine the figures after this impact test, we do not get that considerable increase. In fact, in one case we got a lower figure when we had a small quantity of magnesia than in the

compound without magnesia. It is interesting to note that these figures show the same relationship between the resistance to stretching and the tensile strength as we obtained in previous series of tests. They seem to run more or less proportionately.

Mr. Kelway Bamber: When I was home for the previous Exhibition we sent home some samples to be vulcanised in one of the rubber factories and they showed me the results. I found they were exceedingly porous. They suggested putting magnesia in and they got an absolutely continuous sample which gave totally different results. I cannot say what was the cause of it, but it had a marked effect on the rubber.

Dr. Stevens: Was the rubber from young trees ?

Mr. Kelway Bamber: No; seven years old.

Mr. Clayton Beadle: Of course, there is a great distinction between the method of applying this test for breaking a specimen of metal and the way we apply it to rubber. It is more of a ballistic test in the case of breaking the metal. It breaks the metal transversely. This impact test, as far as I know, was first applied to rubber by Lester. He seems to believe it was the first application of this method. Dr. Memmler showed in his lecture a machine which I think he called an impact tester, with a pendulum. He used the pendulum for testing the resiliency of rubber. It struck another pendulum which carried a piece of rubber, and, as far as I could understand it, the rebound of both pendulums was measured. That, of course, is quite another matter. I am inclined to think, with regard to what Mr. Bamber said, that the first sample may have contained moisture resulting in porosity, but that might have been overcome by the addition of magnesia.

The Chairman: In closing the discussion on this paper and passing on to the next, I may say, as regards this last point, that the reasons for porosity are very numerous and often very obscure.

MECHANICAL TESTS FOR RUBBER.

By K. MEMMLER, Dipl. Ing.,

Königliches Materialprüfungsamt, Gross-Lichterfelde.

Dr. TORREY in the chair.

The CHAIRMAN: We are to listen to a paper by Mr. Memmler. None of us need any introduction to his work. Unfortunately the English translation is not available and therefore Dr. Memmler has very kindly consented to read his paper in English, and merely asks that you will be indulgent with him in any small mistake he may make. This, I am sure, is a very unnecessary appeal.

For the last few years the Königl. Preussisches Materialprüfungsamt of Gross-Lichterfelde, near Berlin, has added to its other work on the chemistry of rubber, studies of mechanical tests for soft vulcanized rubber. Part of the results reached have already been published in the "Mitteilungen aus dem Königl. Materialprüfungsamt," as well as in the proceedings of the "Verein zur Beförderung des Gewerb fleisses," by A. Schob and myself. Furthermore, in a book by my colleague, Prof. Hinrichsen, and myself, entitled "Rubber and its Tests" (Leipzig, 1910, S. Hirzel) I have attempted to give an idea of the present status of mechanical rubber testing and a critical review of literature on the subject down to the present time. Prof. Martens, to whom other lines of material testing owe so much of their progress, and so many new pieces of testing apparatus, also brought his ability and experience to bear on this subject so far as possible, and has designed a number of new testing machines for the mechanical examination of rubber, some of which I am permitted to exhibit here: of these I shall speak. I now ask your attention to a brief statement of the experimental work we have done in this line, and the results thereof.

In our testing laboratories it has always been the rule—when entering on any new department of material testing—to study carefully first the details of the testing process—*i.e.*, the mode of making the

tests, form of test pieces, and the accompanying measurements—before undertaking to study the characteristics of the material itself, even though this course might entail a very long series of experiments. We have adhered to this principle in our studies on mechanical tests for rubber. At the outset we found—whenever there was any practical use of such tests—the breaking test only, a strip or ribbon-form test piece being used. Our first task, then, was to study the various forms of test piece. This has been done; and for our results and our conclusions I will refer you to a paper in the "Mitteilungen aus dem Königl. Materialprüfungsamt," Vol. IV., 1909, entitled "Beiträge zur Frage der Mechanischen Prüfung von Weichgummi," by myself, in conjunction with A. Schob. All I can do at this time, without being too diffuse, is to give the following brief summary.

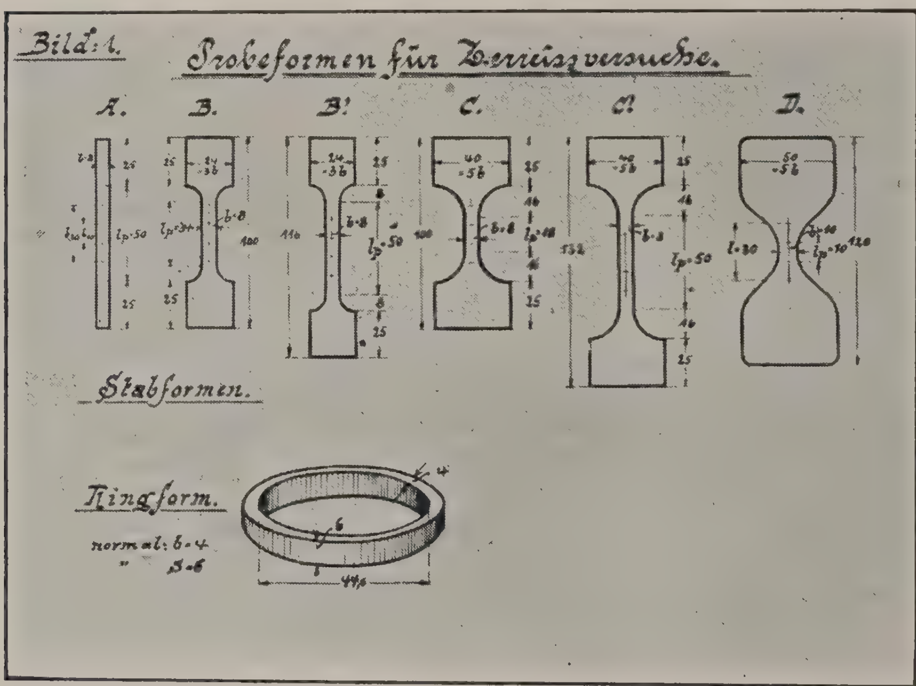


FIG. 1.

Experiments were made with six different kinds of rubber, and six different forms of test piece (shown in Fig. 1), using a Schopper-Dalén machine altered so as to permit the use of single strand test pieces in determinations of stretch, resistance to tensile strain and extension at time of fracture. We have thus been led to the conclusion that this form of test piece is objectionable as a standard form in such tests on rubber. The chief difficulty comes in gripping the piece in the machine, and also in the circumstance that very elastic, *i.e.*, high grade samples almost always break in the portion gripped by the machine and not in the free part between the two grips—which leads, of course, to erroneous results. It is not altogether easy to make suitable test pieces of this class with enlarged ends. Furthermore, the measurement of extension under tensile strain presents, under these circumstances, some difficulty of which we shall say something further on.

In the hands of an untrained observer, then, this form of test piece might lead to wrong conclusions as to the characteristics and the value of the material under examination.

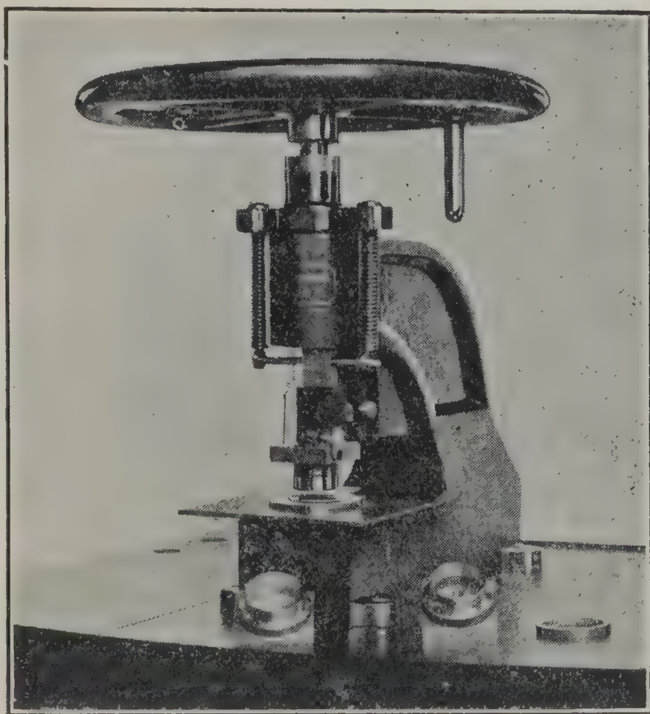


FIG. 2.

We then made, a series of experiments using a ring-shaped test piece. The Schopper-Dalén machine was employed and the same six kinds of rubber. At first we had some difficulty in cutting out the rings cleanly and accurately by means of the Schopper cutting press. (Fig. 2.) Mr. Schob has bestowed much labour on this point, and has finally found that by using a suitable form of cutting ring, he can obtain smooth and truly cylindrical rings. Full information as to the equipment required and the mode of working will be found in the paper cited above ("Mitteilungen aus dem Königl. Materialprüfungsamt," 1909. Vol. IV.). Mr. Schob has also obtained excellent results by cutting out the rings on the turning lathe with a sharp knife. (Fig. 3.) I have here for exhibition specimens of rings prepared by both of the methods mentioned.

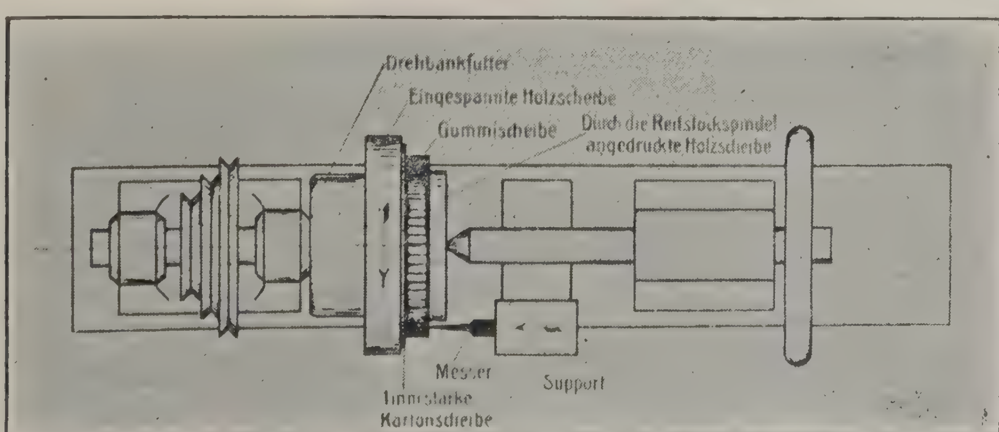


FIG. 3.

In the course of tests made with such rings it was found that they possessed some advantages over the single strand form. The preparation of the test piece, the mode of employing it in the testing process, and the measurement of the stretch are all simpler, and the results more reliable. In case of very elastic material the ring is decidedly superior since single strand test pieces tend to break in the clamp or jaw of the machine, as has been stated. For further reasons in support of the ring-form test piece, I may refer you again to the previously mentioned paper.

On the other hand, we must not overlook the fact that there are some difficulties with this form.

In the first place, it is necessary to have a sheet or strip of the vulcanized material of a size permitting a ring of the required size to be cut. This condition is only met in case of goods such as sheet or strips, hose and the like. Where a ring is impracticable, a band or ribbon can be used in connection with an arrangement devised by Mr. Schob, and shown in Fig. 4, though I must add that we have not yet experimental results to produce.

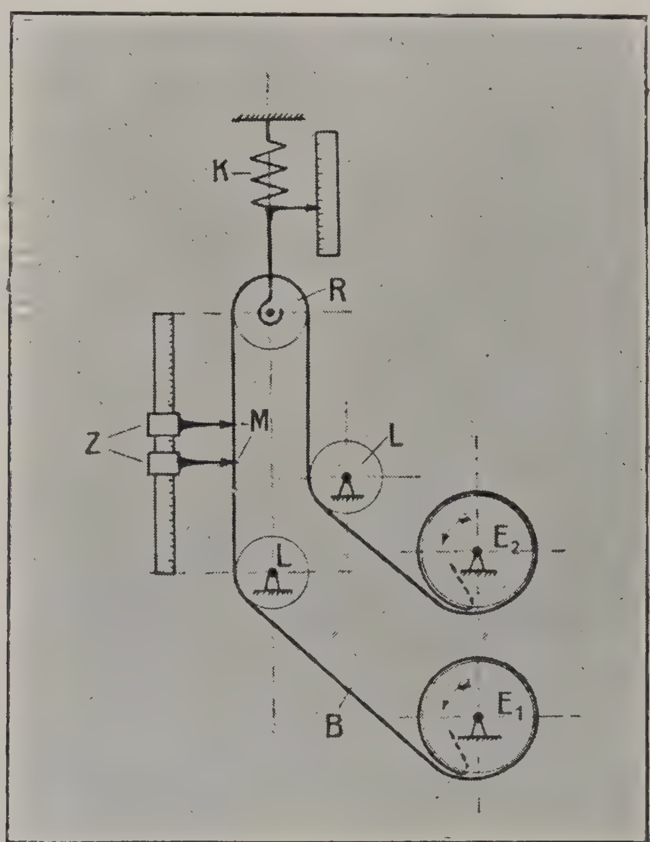


FIG. 4.

This first difficulty encountered in using rings applies, to a certain extent, to the single strand form as well, for it is not always possible to cut such a test piece from the sample at hand. The last objection to the ring leads us into the general question of the mechanical testing

of rubber. I shall not stop to enter on this question just now, but towards the close of my remarks I shall return to it.

As a result of its experience in trying the ring against the single strand, the Testing Office felt warranted in deciding to use the ring in strength tests whenever possible; the next thing in order was to institute experiments calculated to furnish data as to the general availability of this form in such work. We have, therefore, endeavoured, by means of a large number of experiments with different kinds of rubber, to answer the following questions :—

1. What influence has the motion of the ring during the test (due to the motion of the rollers on which the ring is carried, in the Schopper machine) on the results, *i.e.*, are different results obtained when the ring is not allowed to rotate ?

2. What influence has the mode of cutting the ring on the results? Has the method hitherto used (*i.e.*, the Schopper press) "made good"?

3. What influence have variations in the selected dimensions of the rings (breadth, thickness and diameter) on the strength test, the rings being all cut by the same method ?

A full account of this work is given in the above-mentioned paper by myself and Mr. Schob. I here give only a brief abstract.

Ring form test pieces have often been employed in the past by other investigators, such as Stévart, Breuil, and others, but as a rule without allowing the ring to resolve on the straining rollers. It is, therefore, important to know just what effect this movement has on the results.

The experiments on this point led to surprising results, for it was found that with all four of the tested specimens lower results were obtained when the rings were stationary than when it was in motion throughout the test. In case of one specimen stationary rings gave a 75 per cent. smaller result. Furthermore, the breaking strains with stationary rings, unlike those with moving rings, gave results which were inconsistent with the known qualities of the specimens tested (*i.e.*, elasticity, chemical composition, etc.). The measurements of stretch are also worthy of note. They are given in the table 1, and it will be seen that there is a notable difference in the results according as stationary or moving rings are employed. We are then warranted in concluding that when ring form test pieces are used in strength tests of soft rubber, the results are reliable only when the ring is in constant motion on the stretching rollers throughout the test.

The question whether the mode of cutting the rings affects the results is also a very important one. We have already stated that we in the Testing Office have prepared rings both with the Schopper cutting press and on the turning lathe with a knife (see Fig. 3). With regard to the first of these methods, one would think that with a quick acting,

TABLE 1.

COMPARISON OF BREAKING STRENGTH USING RINGS IN MOTION AND STATIONERY RINGS. (BREADTH OF RINGS = 4 mm.)

Material.	Rings in motion or stationary.	Breaking strain (Kg./sq. cm.).	Ratio—taking the result with turned rings as = 100.
I.	In motion	117.7	100
	Stationary	60.4	51
II. a	In motion	90.8	100
	Stationary	21.5	29
V. a	In motion	97.1	100
	Stationary	56.0	58
VII. a	In motion	27.3	100
	Stationary	24.7	91

powerful press the rings cut therewith would possess an advantage which might show itself in the results; but by testing 100 stamped rings and 100 cut rings, using in each case two very different quality rubbers, it was found that the breaking strain results were sensibly the same whether the rings were stamped or cut. One may, then, use either method, though obviously it is better to use the same method when making comparative tests of two or more qualities.

As to the general use of ring form test pieces, it is of prime importance to determine, at the outset, what are the most appropriate dimensions for the rings, and to what extent the strength tests are affected by this circumstance.

To this end we have carried out, in the Testing Office, a very long series of experiments, using rings of constant thickness (6 mm.) but with breadths of 1, 2, 3, 4, 5 and 6 mm.; and another series in which the constant breadth was 1 mm., and the thickness 1, 2, 3, 4, 5 and 6 mm. The samples in both series were cut from three different grades of rubber. The results are given in the previously cited paper. The most noteworthy of the results are given graphically in Fig. 5, and they may be seen in form of a large wall diagram at the exhibits of the Testing Office. It appears from these results that the stretch tests show no influence traceable to the cross-section of the ring. On the other hand, the strength tests are affected by this circumstance, and the softer and more elastic specimens show this influence more than the poorer and less elastic kinds. This certainly suggests that the superficial stretch comes in play here, and obviously those specimens that undergo a large change of form during the testing process will show this partciular effect more than those where the distortion is less pronounced. We could discern no effect determined by the inner diameter of the test ring in either the stretch tests or the strength tests.

Besides these systematic studies we have been studying the possibilities of other methods of testing (*i.e.*, other than the breaking test)

as a means of grading different rubber mixings. The firm of L. Schopper has accordingly built for us a "long period" testing machine after specifications furnished by Prof. Martens. This machine is shown in Fig. 6, and you can see it at our stand in the Exhibition. By means

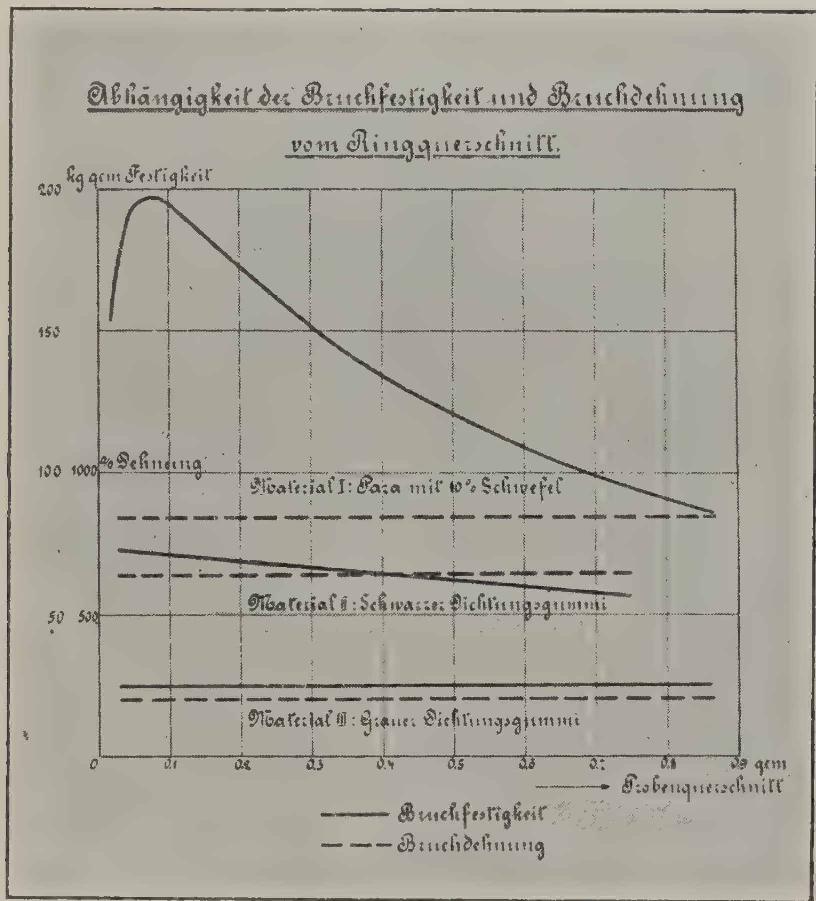


FIG. 5.

of it we can test four rings at once under extensions varying from a minimum to a maximum value, the corresponding stresses being automatically recorded. When a ring breaks the recording mechanism stops. After the stresses, strains and recoveries up to the elastic limits have

FIG. 6.

TABLE 2.

DURATION TEST ACCORDING TO MARTENS, USING DIFFERENT MIXINGS.

Mixing No.	Designation by Firm Supplying.	Greatest % stretch observed.	Mean number of stretches and releases before breaking in three Parallel Tests.	Remarks.
1	Para with 10% S Fully Vulcanised	86 86 86	130,000	Inner surface of Rings showed abrasion as test progressed.
2	Same mixing but 25% Under Vulcanized	87 87 87	156,050	Strong abrasion of inner surafce and before breaking many surface cracks showed in outer surface.
3	Same mixing but 25% Over Vulcanized	86 86 86	96,310	No abrasion effects. Surface cracks on inner surface.
4	Same mixing but 50% Over Vulcanized	86 86 86	60,980	No abrasion effects. Surface Cracks on inner surface.
5	Dark Para Mixing, Fully Vulcanized	79 80 80	11,830	Surface Cracks on inner surface.
6	Mixing A. Fully Vulcanized	84 83 83	2,770	After a few applications of load, strong permanent set. Surface Cracks on inner surface.
7	Mixing B. Fully Vulcanized	84 84 84	4,320	Cracks on lateral surfaces.
8	Mixing C. Fully Vulcanized	74 74 74	1,420	Surface Cracks on inner surface, after about 200 applications of load.

been recorded, the remainder of the record is obtained by a special mechanism under equal stresses for all the rings. The table 2 gives some typical results of duration tests made in this way.

In order to study the progress of linear extension in soft rubber under long continued stress, we have subjected to test a number of single strand test pieces representing different mixings, in the simple form of apparatus shown in Fig. 7. Here each test piece is subjected to a constant stress of 2 kilo. per sq. cm. for a long time. By means of cross marks made on the test pieces the strains are measured, the load being kept on until after the lapse of several days, no further increase in length can be observed. It is then released and the reverse process (*i.e.*, the gradual return toward the original length) followed in the same manner.

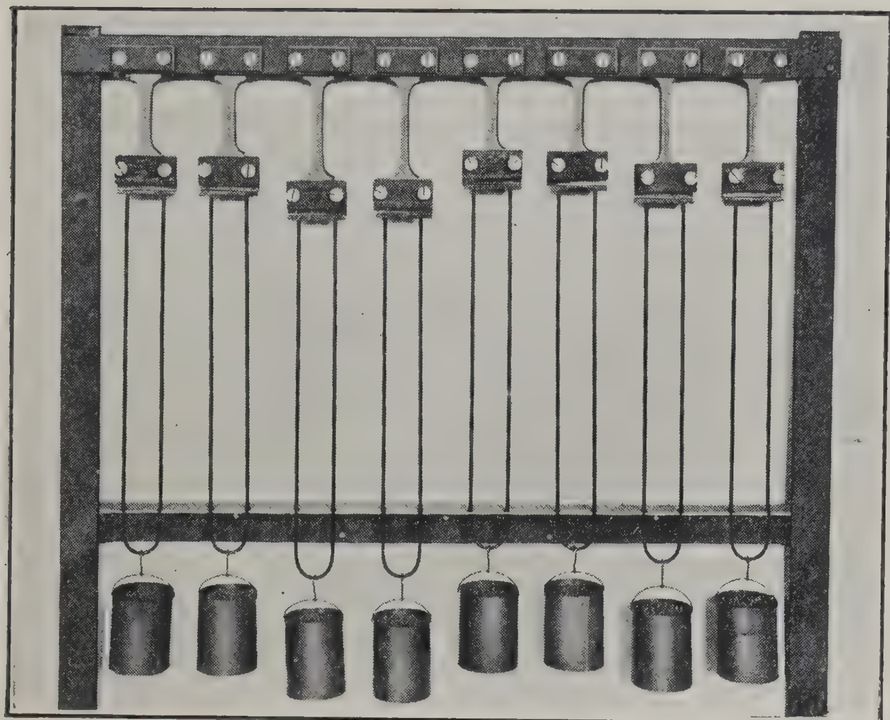


FIG. 7.

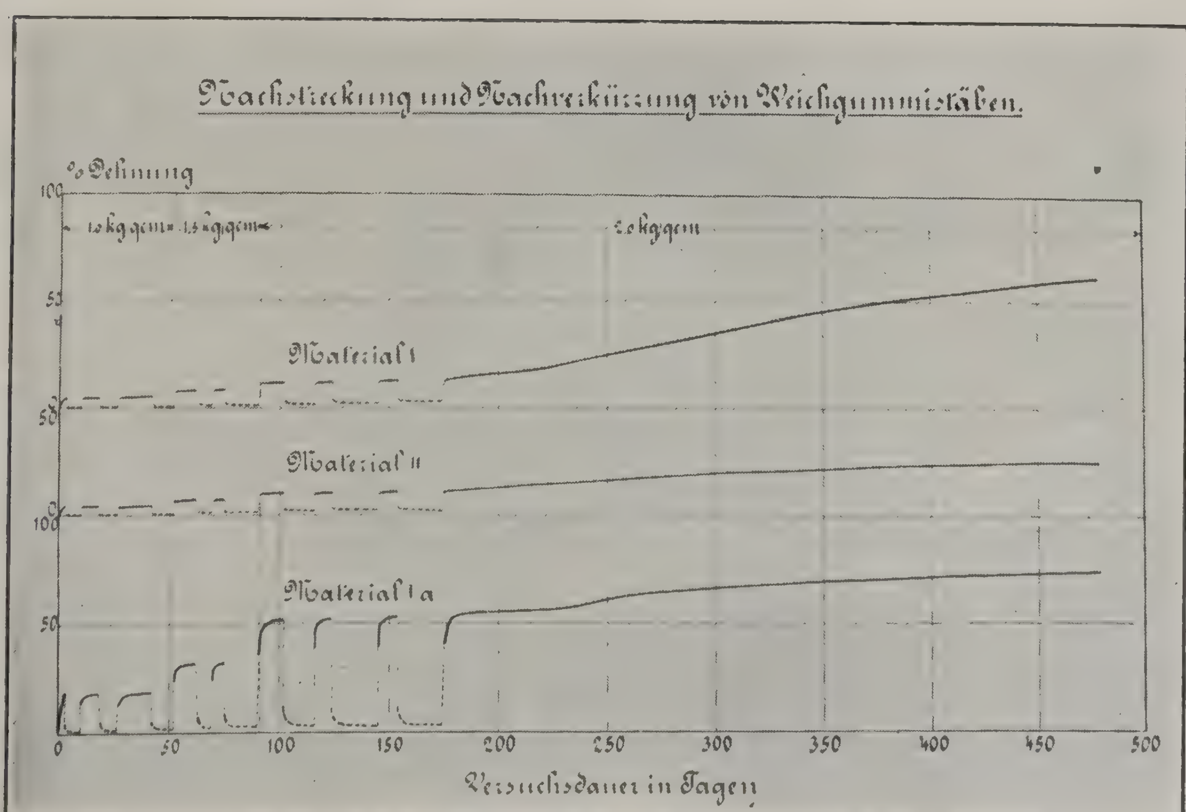

Nachstreckung und Nachverkürzung von Weichgummistäben.
% Dehnung
Material I
Material II
Material Ia
100
50
0
50
100
150
200
250
300
350
400
450
500
Versuchsdauer in Tagen

FIG. 8.

The results are shown graphically in Fig. 8, and you will observe —particularly if you examine the bottom curve—that the change in length does not take place continuously. There are irregularities from time to time. The explanation of this may be that the initial rupture takes place on the surface of the test piece and from thence gradually penetrates to the interior. This results in local diminution in cross-section, and, of course, increased stress per unit of cross-section area, the total load being constant; this results again in an increase in the stretching stress, and to this stress the unaffected interior portion of that cross-sectional plane responds by an increase in length. These samples have hung in the Testing Office for about two years now, under constant observation. Fig. 9 shows the appearance of one of them.

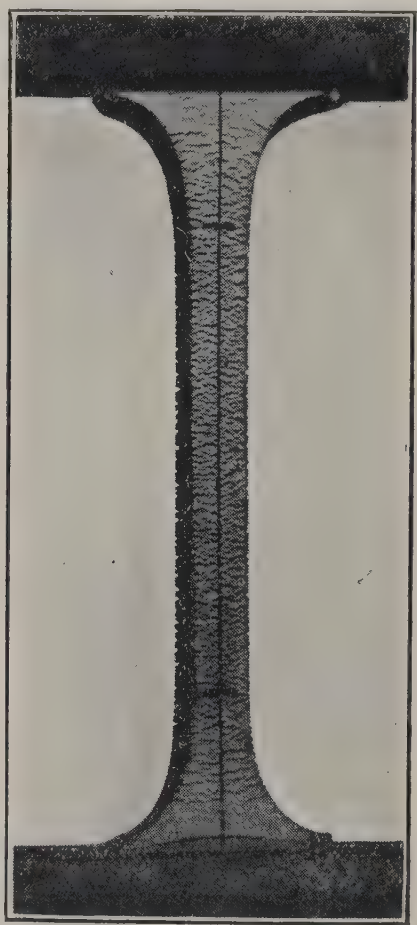


FIG. 9.

According to another proposal of Prof. Martens, long-period tests will be made on ring form test pieces, in the following manner: the rings are stretched over glass plates as shown in Fig. 10. They are thus exposed to a constant stretch which can be calculated, seeing that the breadth and thickness of the plates are known. It is then easy to study them under different conditions of moisture, dryness, temperature, etc., in the open air and under weather conditions. Any changes can be readily observed—and just at this point I will say that in order to ascertain the effect of storing out the strength of soft rubber a very long series of experiments were carried out by the Testing Office, which are dealt with in our book "Der Kautschuk und seine Prüfung," pp. 251–253.

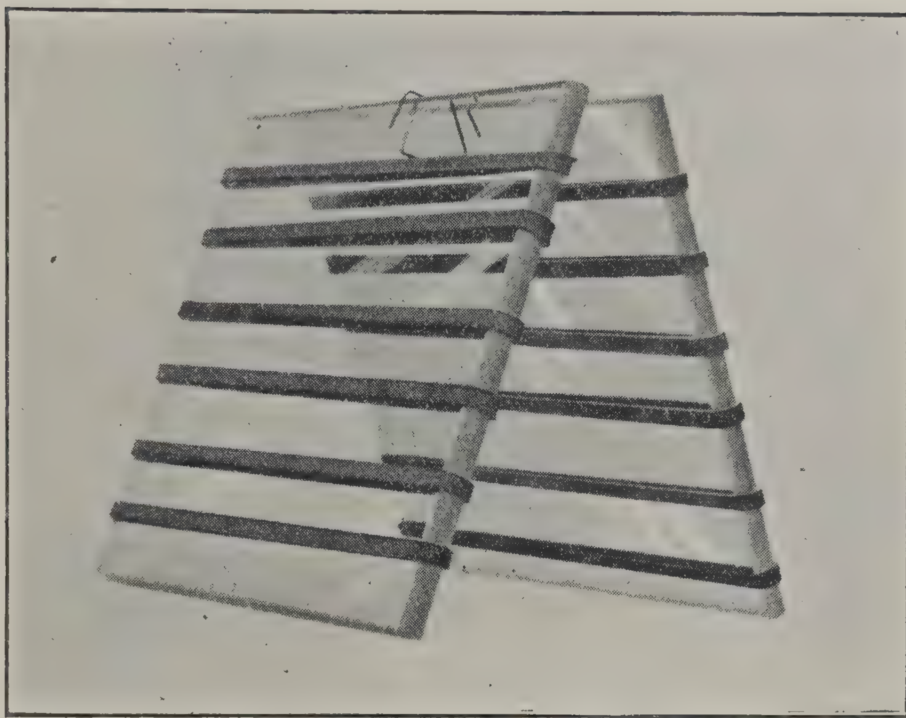


FIG. 10.

Among other duration tests used by us I should like to mention a re-designed form of the crimping or folding machine which has been used for many years in the testing of paper with good results. The machine, as adapted for rubber testing, is shown in Fig. 11.

In this machine a strip cut from a sheet of rubber is exposed a certain tension by means of two right and left spiral springs. It is then secured in the vertical slot of a reciprocating crosshead by means of which the strip is bent this way and that at or near its centre as long as the machine is kept in operation, thus developing "fatigue" of the material.

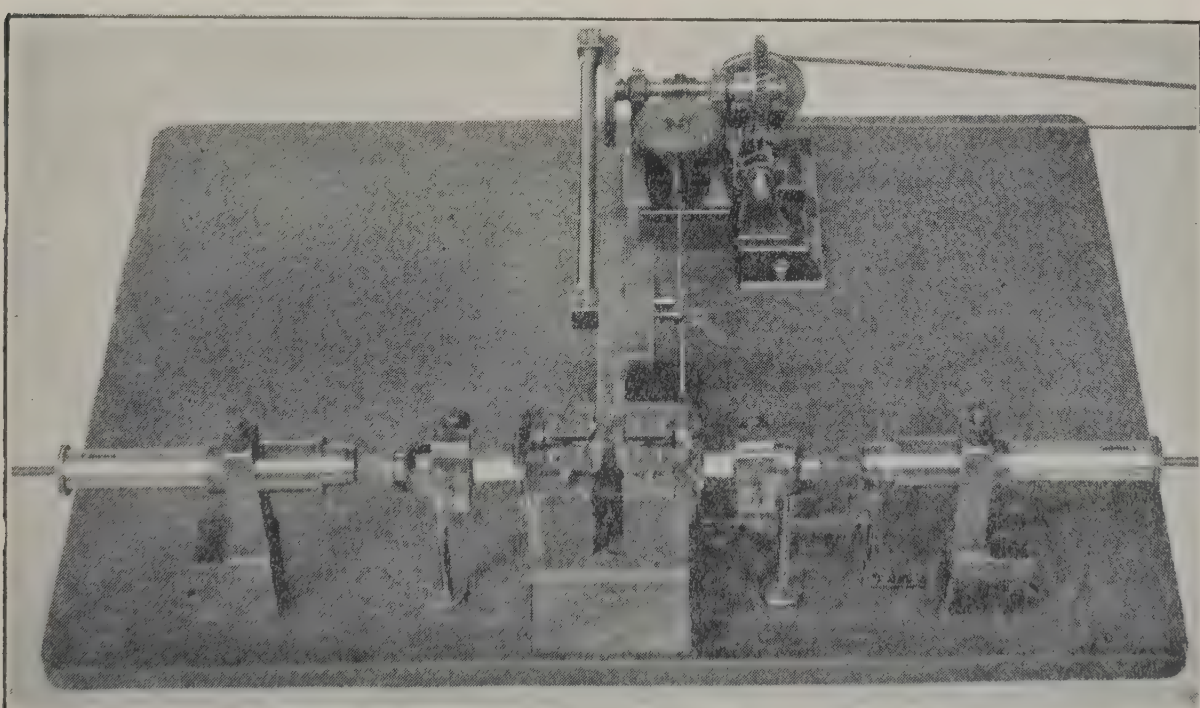


FIG. 11.

Prof. Martens has also lately designed a machine for testing simultaneously ten soft rubber rings. A first edition of this machine is on view at our stand, and you can there see its practical use demonstrated. Its mission is to give all the ten rings the same determined number of equal stretches. Before and after this operation there will be strength tests, and by the data thus obtained the samples will be classified.

In some technical applications of soft rubber a most important point is the deterioration of the article by wear of the working surface (in motor tyres, for example). The Office has sought to meet this problem

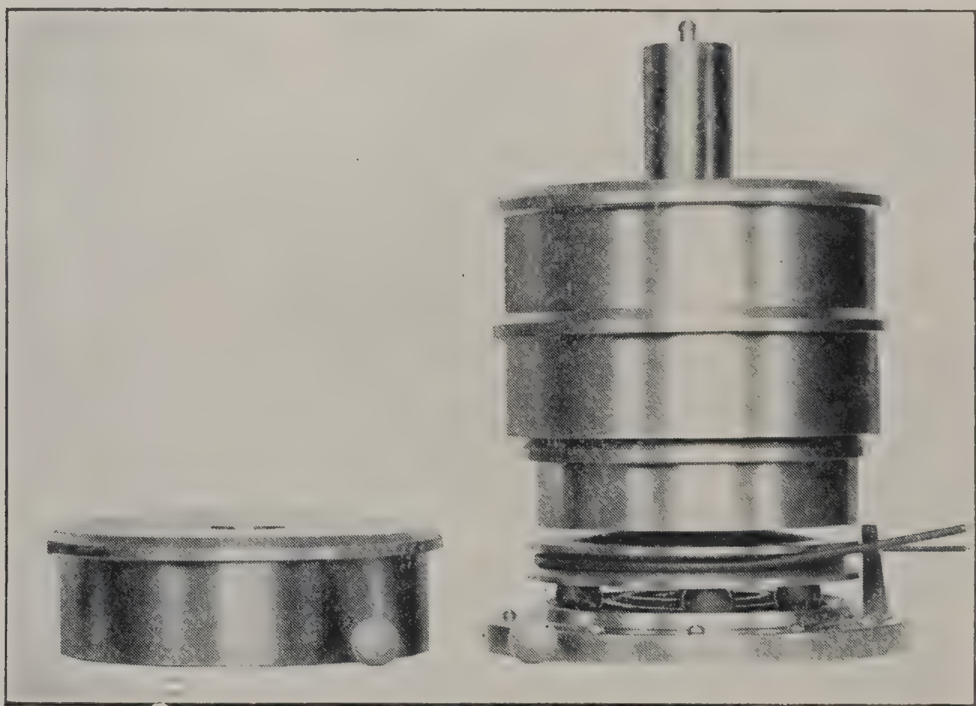


FIG. 12.

by devising a method for comparative abrasion tests of vulcanized rubber mixings, and to this end two forms of testing machine have been designed and tried.

Prof. Marten's machine is shown in Fig. 12. Balls of the vulcanized mixings to be tested, 30 mm. in diameter, are placed between two metal discs. The lower, which is stationary, has in it a V-shaped annular groove. The top disc is flat and revolves. The pressure is determined by weights laid on the top disc. By this constant travel under load the balls gradually wear away on the surface and also fail through "fatigue" of the interior portions. The progress of this is determined by the loss of weight after a certain number of revolutions under known load—as well as by the other signs of failure. Fig. 13 shows the extraordinary differences shown by various sample balls tested in this way.

A second machine has been designed by mechanician Mai, of the Testing Office. It is shown in Fig. 14. Rings such as are used for strength tests in the Schopper Dalén machine are caused to revolve between two rolls which are pressed together by a determined weight. The wear is shown by the weight lost, and different mixings can be thus compared.

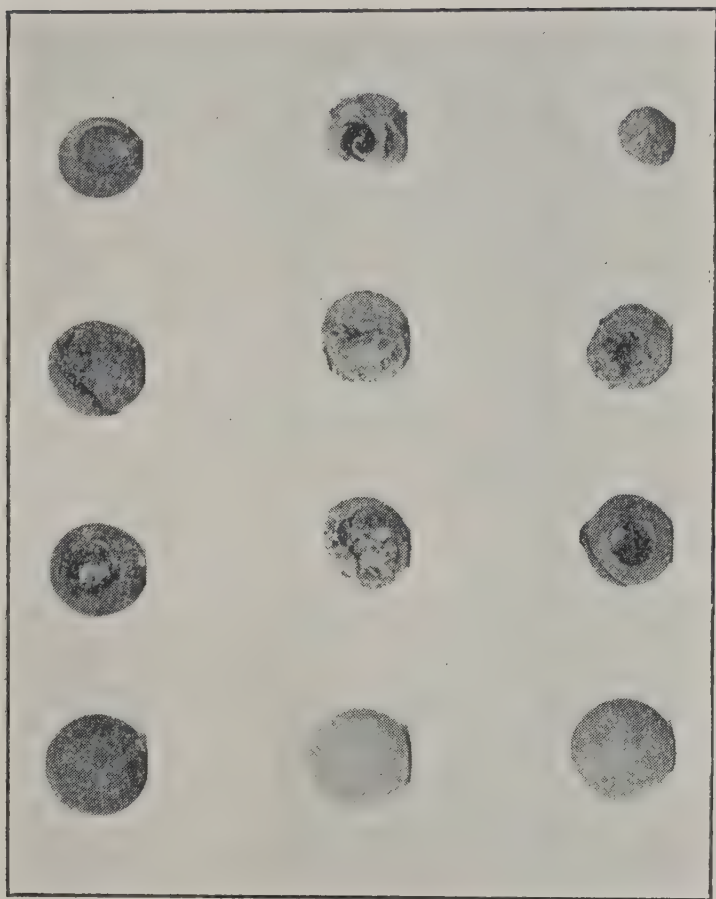


FIG. 13.

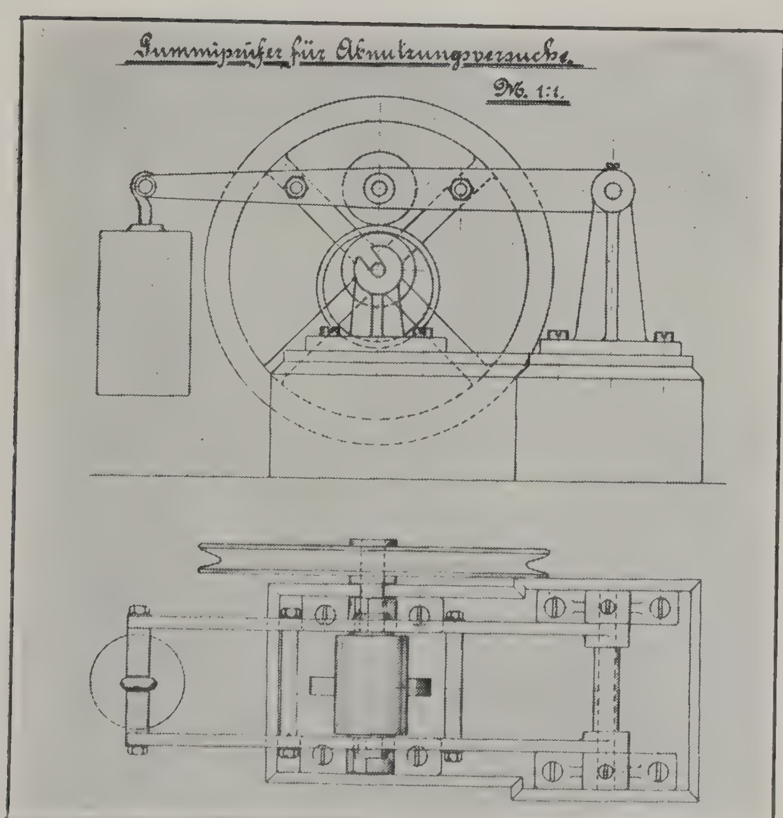


FIG. 14.

You can see from Fig. 15 how different are the appearances of rings from different mixings after this treatment. Fig. 16 shows graphically the progress of the wear in two different specimens. For further data I would refer you to our exhibit, where you can see both these machines, and in the show cases near them characteristic results of tests made with them.

It will soon be possible for the Office to turn its attention to another question, namely, the appropriate form of test piece and the best form

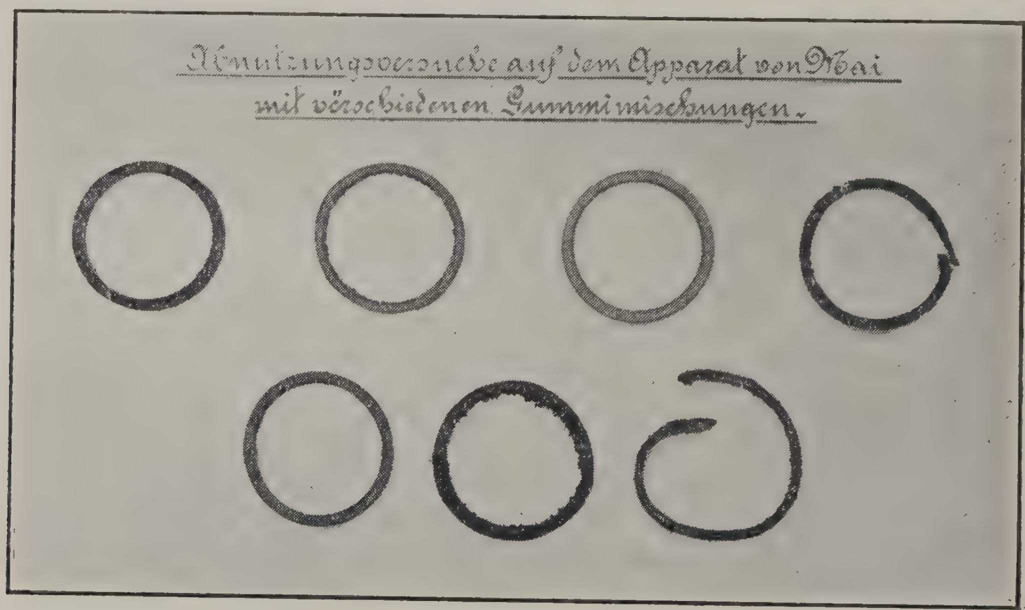


FIG. 15.

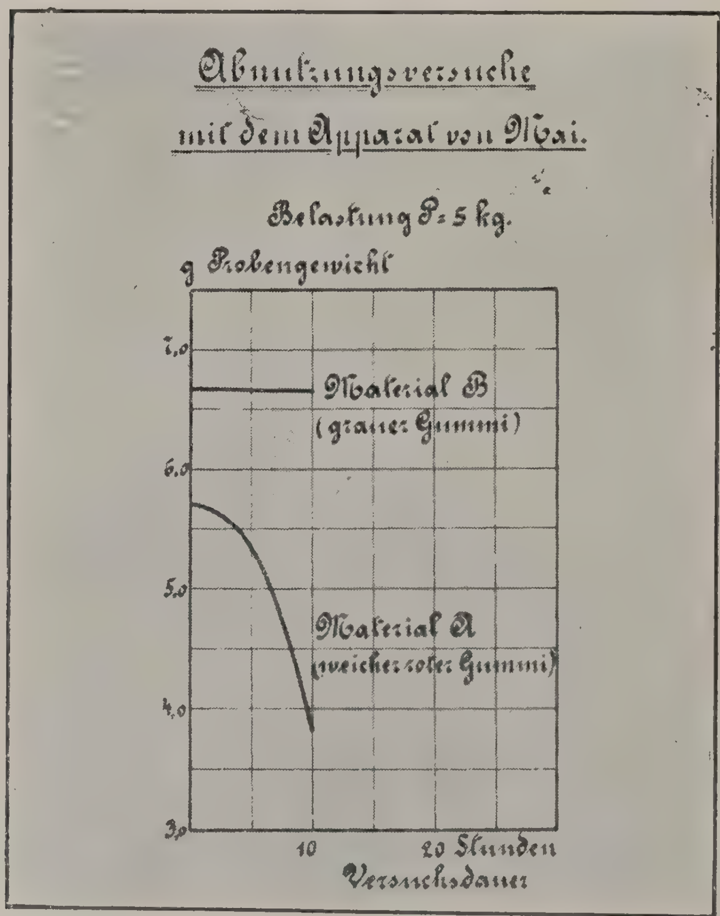


FIG. 16.

of apparatus for use in compression tests. To this end a press has been built, after designs of Prof. Martens, by which six rubber cylinders can be compressed at once. A first edition of this machine is shown in Fig. 17, and from it you can see how it is constructed. It consists of six hydraulic cylinders of different diameters, all supplied with water at a uniform pressure of two atmospheres. By this means we can subject the six test cylinders from the same mixing to different pressures, since obviously the cylinders give different total pressures for the same water pressure per unit of area. Suitably arranged index pointers enable the corresponding compressions to be read off.

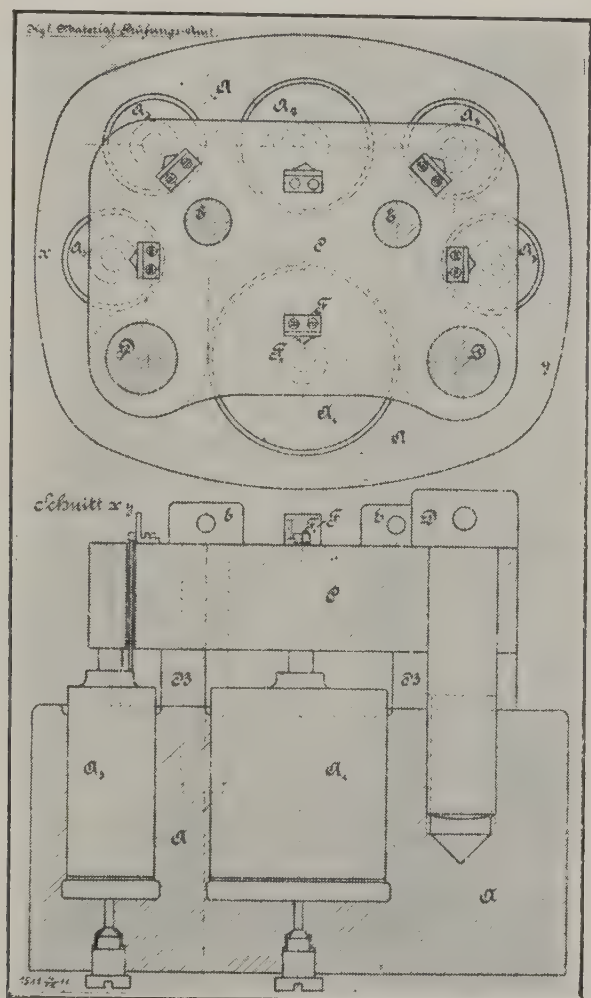


FIG. 17.

Another piece of apparatus constructed by the Office enables us to study the resistance to penetration shown by rubber discs according to the Brinell "pressure hardening process." A small steel ball is brought to bear on the test disc with a known pressure determined and regulated, between limits, by a suitably dispersed weight. The depth of indentation can be read off on a suitable scale and the results given by different mixings used for comparison. We are now testing in the office a new apparatus made by L. Schopper, of Leipzig, for ascertaining the degree of elasticity of rubber and similar materials. The construction of the machine is shown in Fig. 18. The principle of the apparatus is that of the pendulum-impact-tester. A rubber disc, 5 to 10 mm. thickness, and 1 sq. cm. area is fixed on the face of one of the pendulum-hammers. The left pendulum hammer comes, after being released, against the right one. The impact energy absorbed by the rubber disc and also the surplus energy not absorbed is indicated by the position of pointers, which are loosely fixed on the axle of the pendulum and move over a scale.

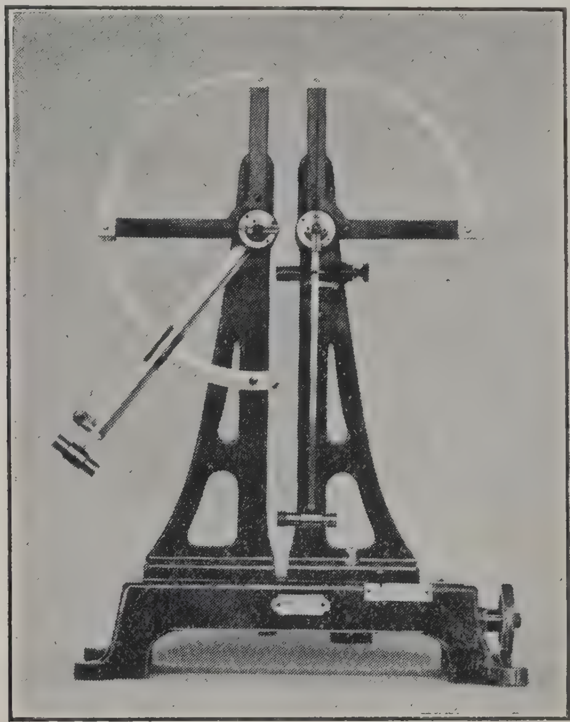


FIG. 18.

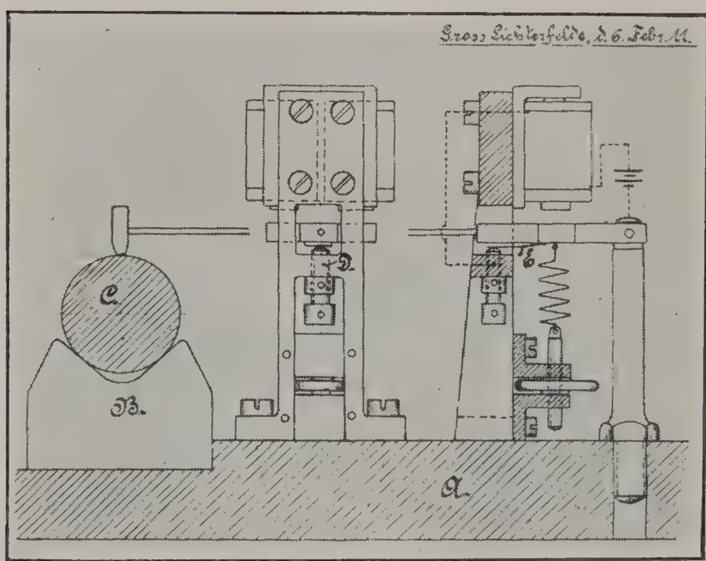


FIG. 19.

Certain other pieces of apparatus designed in the Office and partly constructed there serve to test certain finished products of the rubber industry. These can be seen at our exhibiting stand: for the present I refer you to the illustrations. Fig. 19 shows an apparatus for testing typewriter rolls—designed by Prof. Martens. By this apparatus we can observe the behaviour of the roll under mechanically actuated blows of a small hammer—such as it has to meet in actual use.

Fig. 20 shows a machine for testing the bursting pressure of balloon fabrics. A circular sheet of the material is stretched on a plate and burst by compressed air admitted underneath the sheet. The two factors observed are the bursting pressure and the height of the vault formed by the sheet as it inflates. Fig. 21 shows Heyn's apparatus for studying the gas-permeability of balloon fabric. The cloth disc is fitted between two funnel-shaped glasses. Into one of them hydrogen is intro-

duced, whereas the air pressed into the other funnel drives off the diffused hydrogen. The latter is burned to water by means of palladium as best and determined by weighing the water.

Fig. 22 shows Baur's apparatus for determining the heat permeability of such fabrics. Four specimens of balloon cloth to be compared are fitted on the boxes painted black inside. On the back of the discs are mounted thermo-couples, by means of which the temperature is registered at different periods of irradiation.

Permit me now, in closing, to make a few observations on the present status of mechanical tests for rubber.

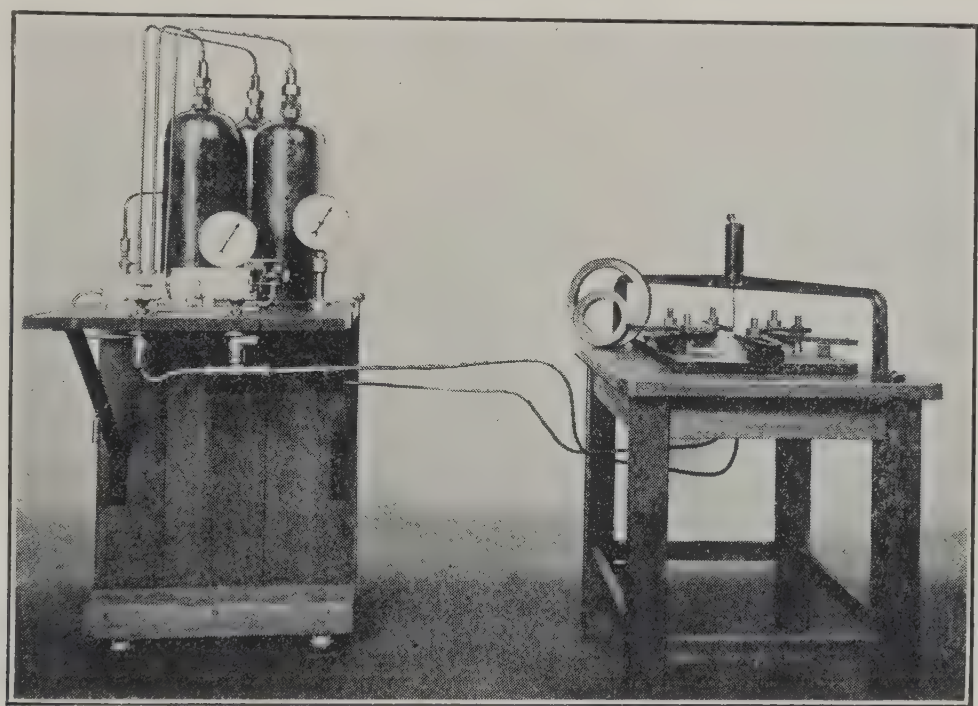


FIG. 20.

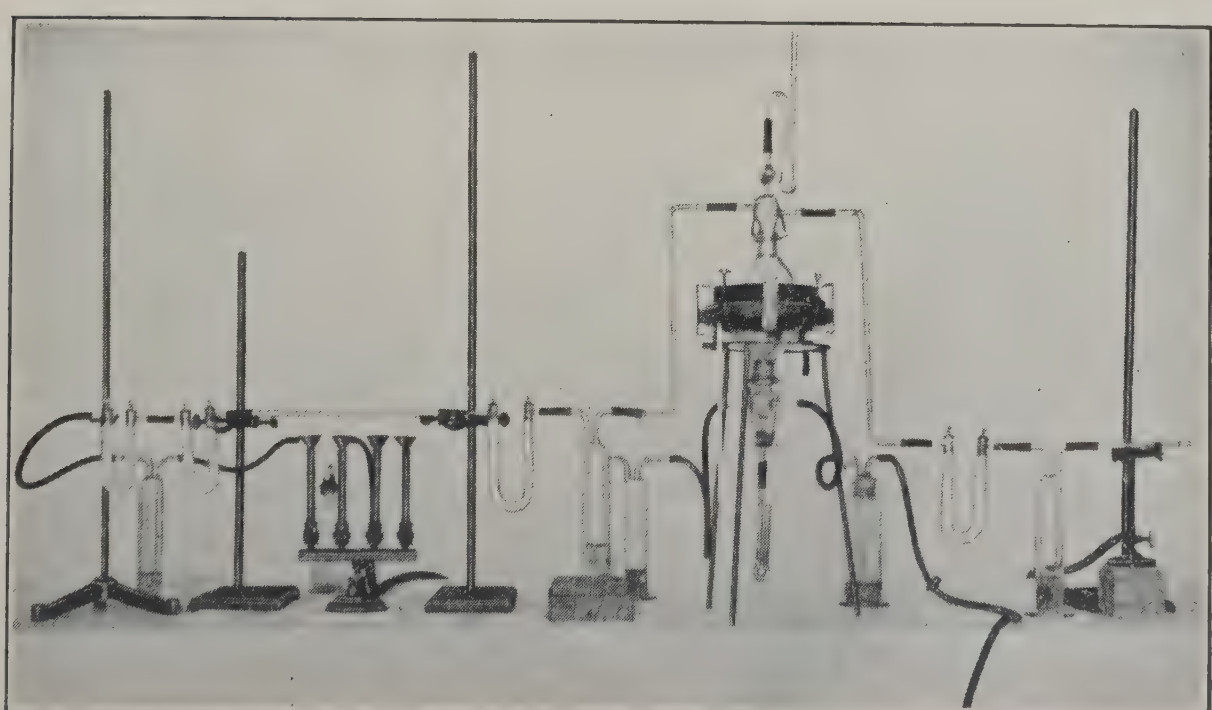


FIG. 21.

You will doubtless have seen, by this account I have given you of the work of our Testing Office, that we in Germany are doing our utmost on this problem, and I see from the literature of the subject that in other countries as well the matter is being energetically followed up. The problem now is to so combine and handle these results that, as a result of the work, the simplest and most generally accepted methods may be adopted for valueing and classifying rubber goods—methods which will serve the interests of both producer and consumer. I cannot regard this matter in the seemingly narrow way in which it has been many times handled in other quarters. I am sure the time is not ripe for any such precise testing processes. Everyone who comes closely in contact with this problem must soon recognize that nothwitstanding all the progress that has been made, his ideas are far from clear as to the limitations of mechanical tests on rubber.

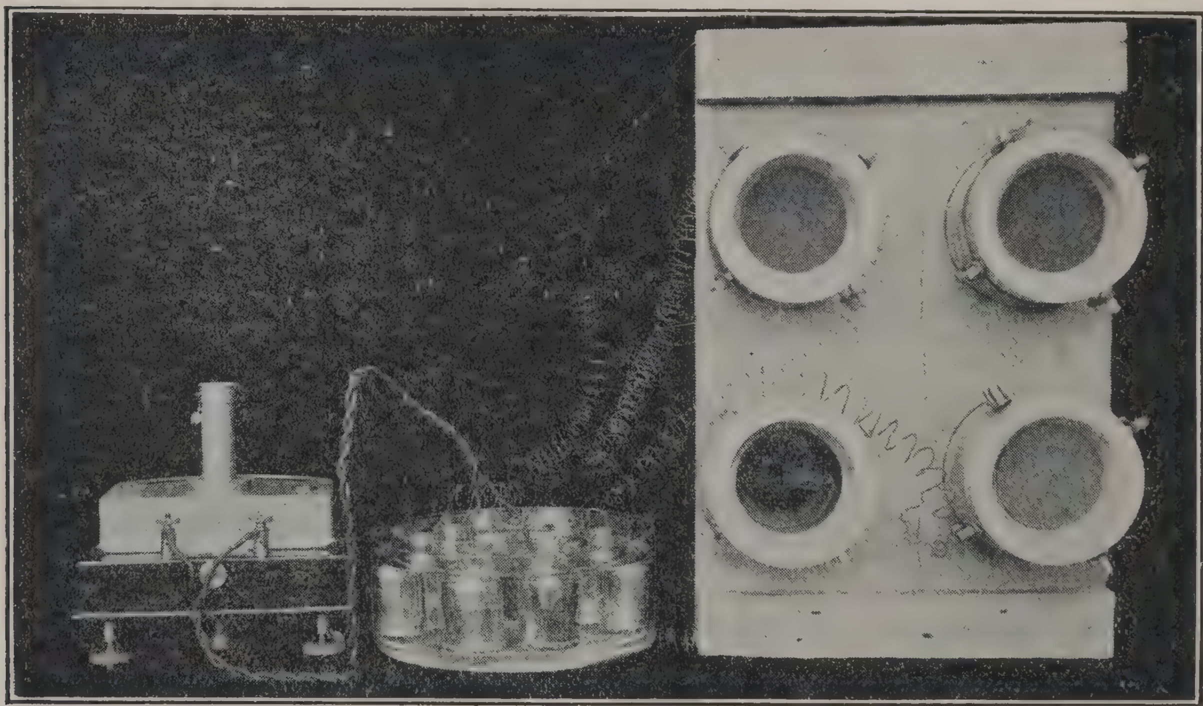


FIG. 22.

The first questions to settle are these :—

a. Are the strength and elasticity tests to be taken indiscriminately, without regard to the manner in which the goods (*i.e.*, hose, sheet, rings, buffers, moulded goods, etc.) are to be used in practice ? or

b. Shall tests be adopted by which the article itself, or a suitable piece cut from it, may be subjected to the same kind of conditions it will encounter in actual use ?

The latter method, although commending itself from the practical point of view, will present many difficulties.

A little reflection will show that the many and varied modes of practical use of rubber articles will make it exceedingly difficult to design adequate testing methods which will ensure uniform and comparable procedure everywhere. On the other hand, the first plan will ensure this uniformity and will not require too much time and material for the tests, which will present comparatively little difficulty.

Although it be granted that we can look at this question to-day from a decidedly advanced standpoint than we could at the time of the 1908 Exhibition, the fact remains that we still await a solution of the fundamental questions, and this must be forthcoming before we can enter on the consideration of higher accuracy in such work.

I shall be very glad if these remarks lead to full and exhaustive discussion.

The CHAIRMAN: In the first place, I think we all owe Mr. Memmler our thanks for the plucky and successful way in which he has carried through the reading of his paper in English under very great difficulties. I doubt if any of us who speak English would have done a tenth part as well if we had tried to read a paper in German. Perhaps I may be permitted a word or two in opening the discussion. I wish to call particular attention to some of the last words in the paper—on the difficulties surrounding the whole question of rubber testing. I think it is one of the first times that I ever heard these adequately recognised, and I doubt if anyone yet realises, even those who have worked at it the most, the difficult nature of the problem we are confronted with here. That little test piece we saw on the screen showing throughout its length the initial fractures is really the danger signal of the whole matter. Of course, it is true that any kind of material tested for tensile strain breaks in the same way. If you watch a piece of steel being tested in a testing machine, towards the very last, just before the piece breaks, if the test is interrupted you can see the same effect all over the test piece, but especially in the vicinity of where it is going to break—you see the little initial fractures. The reason why the piece ultimately breaks in a certain place is because one of these little initial fractures develops more readily than the others. This makes all our work, in which the breaking strain is the ultimate result, a matter of great uncertainty, requiring a great deal of study before it is solved. There is just one other point I would like to mention and that is a point brought up in connection with Prof. Marten's machine for testing four rings at once. There, attention was called to the fact that the specimen which was slightly undervulcanised gave the best results. I think it is a matter of pretty general observation to those who handle a great deal of rubber, and who see a great many tests made in the course of a year, and who have occasion often to determine very carefully the conditions under which the best practical result is developed, that it is best to vulcanise a bit below what you would do for appearance only. You find a greater strength just below where the piece seemed to develop maximum "snappiness" rather than over.

Dr. STEVENS: In the first place I can only re-echo our chairman's words that we are much indebted to Mr. Memmler for reading this paper, particularly for coming over from Berlin and giving us such an excellent and lucid review of the various testing machines which he uses. There are, of course, an enormous number of points which arise in a matter of this sort, but I will limit myself to a few which have occurred to me at the moment. I must apologise for speaking in English, but I know that Mr. Memmler understands English as he does German. I should like to start with the end of the lecture rather than the beginning. I was rather glad to hear that Mr. Memmler—so I understood him—did not consider that we had reached such a stage in the testing of rubber

that it was possible to lay down lines on which tests should be made and that further research is necessary before we fix a standard for testing. With regard to the various abrasion experiments both with the rings and with the balls Mr. Memmler drew attention to the different way in which the abrasion effects had taken place, and I should like to ask him whether he gets a similar abrasion effect with each particular class of pounded rubber, for it may be a valuable test for distinguishing between different grades of rubber goods. I think that the idea of rings stretched on glass plates will lead to very valuable results. We have ourselves carried out a series of experiments on somewhat similar lines, but instead of using plates we have used pegs, between which the rings are stretched. It will be interesting to compare the results of tests made when the samples are stretched to the same limit of extension, with tests made where the samples are loaded with the same weight per inch of sectional area, that is to say, where they are not necessarily extended to the same extent but where the same load is applied. With regard to the under-vulcanisation of some of the samples our chairman has had a great deal of experience in practical technical work, and what he has said we must take great note of, but with the experience we have had I could not agree with the statement he made, that a little under-vulcanisation gave a stronger rubber than full vulcanisation. I can understand that the *abrasion* effect may be less with under-vulcanisation, but our experience has been that the actual tensile strength is at the best when the sample is fully vulcanised. Of course, a great deal depends on how soon the test is made after the sample is cured. Everything depends on that. Of course, the effect of vulcanisation goes on as the goods are kept. We have come to the conclusion that if we give the rubber such a cure that we get the maximum strength soon after vulcanisation has taken place, we have a rubber which sooner or later begins to deteriorate and eventually goes to pieces, that is, it is over-vulcanised. I think Mr. Memmler said it was 25 per cent. under-vulcanisation—I presume that means 25 per cent. short of the time for curing.

Mr. MEMMLER: The number is given by the manufacturer.

Dr. STEVENS: Of course, if 25 per cent. under-vulcanisation means that the sample has been vulcanised only 75 per cent. of the time necessary to fully valcanise it, the under-vulcanisation would be considerable. I presume such a rubber would not be used technically, so that the results obtained by Mr. Memmler are all the more interesting, and I should like to ask him if he has any idea as to what temperature the rubber became heated in the course of the test. Was the temperature sufficiently high to bring about vulcanisation? Was it above 110° or 120° C.?

Mr. MEMMLER: No, I think it was about 70° to 80° Centigrade.

Dr. STEVENS: That is a temperature at which it is admitted that no vulcanisation as ordinarily understood can take place.

Mr. MEMMLER: You must bear in mind the long duration of the test.

Dr. STEVENS: I know that when rubber is cured it undergoes what may be described as a further vulcanisation effect on keeping and that this may be faster at higher temperatures, but the point was that the temperature was not such at which vulcanisation as ordinarily understood

will take place. If further vulcanisation takes place motor tyres should be made 25 per cent. under-vulcanised, but I think that is hardly the experience of manufacturers. Now I come to what is perhaps the most difficult test to make on rubber—namely the determination of the tensile strength and it appears to me that there is a source of error when using a ring which has not so far been referred to and which is really larger than would at first appear. I refer to the difference in length of different parts of the test piece. The internal circumference is smaller than the external, and I should like to ask Mr. Memmler whether he takes the internal circumference, the external circumference or the mean of these when reckoning the elongation of these rings.

Mr. MEMMLER: No; we take the distance between the rollers.

Dr. STEVENS: I can quite understand that one takes one's measurements from the distance between the two rollers, but I cannot follow from that how the length is measured. I presume it is calculated and allowed for and the scale adjusted accordingly.

Mr. MEMMLER replied in German, and explained the measurement of the Schopper machine.

Dr. STEVENS: I will explain what I mean. We will take the case of a ring—I do not know the exact diameters of the rings used, but we will take it that they are 40 mm. The external circumference we will say is 48 mm. The length of the internal part of the ring, when extended, shall we say 1,000 per cent., would be 10 by 40. The sectional area of the ring is 20 sq. mm., that is, just 4 mm. one way and 5 mm. the other. As the volume of rubber does not appreciably alter on elongation it follows that the sectional area of the ring when extended to 1,000 per cent. will be 2 sq. mm., that is, 5 by 4 mm. Taking now the measurement of the external diameter, this is 48 mm. to start with and when extended 1,000 per cent. in the length will be 10 by 40·8. Now, supposing we have so extended the rings that the internal circumference is increased 1,000 per cent., the external circumference is increased only 850 per cent., consequently the internal circumference is stretched 15 per cent. more than the external. Now Mr. Memmler will remember that in discussing the question of a plain strip in a machine yesterday I explained that in our experiments that the strip showed an error of something like 7 per cent. owing to the width in the grip above and below, which you quite rightly criticised. We appear to get a greater error with a ring than with a strip when merely elongated. I am not speaking of breaking strain but merely of elongation. This may also explain the different tensile strengths per unit of cross sectional area obtained by Mr. Memmler for rings of the same material but of different sectional area.

Mr. CLAYTON BEADLE: I had an opportunity of seeing the work done in Berlin two years ago by Mr. Memmler, and I am struck by the great progress which has been made since that time, as shown by what he has told us to-day. He has referred particularly to the question of elongation in tests made with a ring and to the fact that similar experience is met with in the case of an ordinary strip placed between two grips. If the strip is elongated, say, 1,000 per cent., or ten times its original length, as the total volume remains the same the mean sectional area must be one-tenth, as the rubber does not alter in volume, but as the grips hold the strips rigidly at each end, of course there is a

resistance to natural contraction in the neighbourhood of the grips, and this resistance to natural contraction necessitates a diminished elongation. Now these strips possess a diminished sectional area in the middle, and if the strips are marked for measuring elongation—provided the marks are placed across the strips out of the centre of influence, as it were, of the grip, and consequently beyond where the diameter diminishes, correct record of the elongation can be obtained, but not if the record is taken as between the centres of each grip. I have noticed on machines where the rubber is cut so as to be wider under the grips or has to diminish from beyond the grips that there is a peculiar effect noticed but that the strip beyond which this narrowing effect reaches has parallel sides. The portions which are parallel at the beginning of the test and before stress is put upon them no longer remain parallel the whole of the length, so care must be taken in recording the elongation that the cross marks are placed, as it were, out of the zone of influence, and between which there is perfect parallel between the sides, or otherwise it is impossible to get a uniform or correct record of what the true elongation is. It struck me that possibly in the sample which was shown over a period of two years, showing that peculiar crackiness all over the surface, the effects might partly be due to natural perishing of the sample as the result of exposure to the air during that period. It seems likely to me that to some extent that may be the cause of the peculiar appearance. Dr. Memmler showed a machine which I do not think was in operation at the time I went to Berlin, a machine for pressing a circular piece of rubber between two revolving rolls, and mentioned that the amount of abrasion was tested by noting the diminution in weight. Are those rolls running at uniform speed, or are they differential speeds?

Mr. Memmler: Uniform speeds.

Mr. Clayton Beadle: And then with regard to the balls; I noticed that you had that method in operation when I was at Berlin two years ago. Is that test applied over a given length of time on all samples?

Mr. Memmler: Yes.

Dr. Stevens: A certain definite amount of abrasion is given to it.

Mr. Memmler: You take a certain definite number of revolutions—60,000 or 100,000. We have always taken 50,000, 100,000 and 150,000 revolutions, and from 1,000 to 50,000 we made about 10 or 15 observations of the loss of weight and so on. It has very often happened that the balls became abrased, and therefore we must stop the test.

Mr. Clayton Beadle: Referring back to the length of the strip and testing elongation, one thing we notice is making the tests between two rigid grips was that there was a difference of 7 per cent. in one sample as measured between two cross marks in comparison with the exact distance between the grips; and in another sample, which was rather thicker, the difference was greater. The error increases according to the thickness of the sample.

These remarks were made by Mr. Memmler in closing the discussion of his paper on Mechanical Rubber Tests.

Mr. MEMMLER (in reply to Dr. STEVENS): I think the point raised by you as to the different amount of stretch in the inner and outer surfaces of the ring-formed test-piece is theoretically very interesting, but not practically significant as effecting the suitability of such test-pieces. Any differential effect of this kind will be constant and, therefore, it is possible to get comparable results working with different samples of soft vulcanised rubber.

Mr. MEMMLER (in reply to Dr. SACHS): Up to now we have, in our work, never had any idea of establishing a standard rubber, or of making the ring-form test-piece standard. We have merely directed our efforts to a careful study of the influence of the form of test-piece on results, that is, to ascertain whether the same features presented themselves in testing rubber as in the case of metals which, as is well-known, give results whose nature depends on the form of test-piece.

I might say further that we have approached a large German rubber goods factory with the request that they furnish us some samples of mixings such as they use in their manufactured goods—both high-grade and low-grade—for testing purposes.

The composition of these samples does not at present concern us, as we are still on the question of testing methods and proper form for test-pieces.

CHAPTER V.—Section II.

(I.) Ernest Hecht.—"The World's Trade in Raw Rubber."

(II.) W. Tinnock.—"Factors Affecting the Valuation of Rubber Shares."

The World's Trade in Raw Rubber.

By ERNEST HECHT.

Rubber, which seems to us to be at the present time an article quite as important as wood or metal, has been known to the human race for a relatively short time.

It was in the second half of the eighteenth century that the French naturalist, La Condamine, while exploring the Cordillerras of the Andes, discovered, on the confines of the territories of Peru and Brazil, in the upper basin of the Amazon, an elastic gum which ran like resin from the trunk of a tree and to which the natives gave the name of *caucho*, which is the name still given to the product of the original Peruvian tree : from this name, too, we have the present French word for rubber, *caoutchouc.*

The natives of the country used this gum, which is easy to coagulate, to make shoes, which were proof against the wet or dampness, utensils of different kinds, as well as dolls and different toys for children.

For a long time the European industry used rubber solely for erasing pencil and ink marks, and the language still shows traces of first impressions ; for to-day we use the name "India-rubber" in English to designate the article which has become so important as to give rise to an exhibition in which the five continents are taking part.

Rubber began to be of use industrially only when the process of vulcanization was discovered ; that is to say, the union with sulphur effected at a high temperature.

This discovery, which several inventors made almost simultaneously (as is the case with most great scientific discoveries) gave us a rubber which would keep its elasticity and impermeability although subjected to different conditions of temperature and pressure ; it also allowed the rubber, under certain conditions, to be rendered very hard, *i.e.*, made into ebonite.

As is generally the case, the ways of using rubber have increased in number from year to year ; but who would then have believed that manufacturers, not content with making waterproof cloth, garden hose, steam packing, toys for children, ornaments, over-shoes, etc., would be now making tyres to be used on wheels which would permit man to increase so greatly the speed of his machines and comfort of travel ?

Again, who would have thought so soon after the invention of the bicycle and automobile which revolutionised the last decade of the nineteenth century—that the first decade of the twentieth century would hardly have passed before one would see not only spherical balloons as in former times and dirigibles with an envelope proofed with rubber,

but machines heavier than air that only attained flight after running along the ground on wheels shod with pneumatic tyres—and that these machines would maintain their flight above the earth by wings made impermeable by means of this same India-rubber, which has so singularly enlarged the sphere within which its modest name would seem to confine it ?

In consequence of the great demand for industrial necessities, the world's commerce in raw rubber is continually increasing.

About sixty years (or two generations) since, the writer's family founded—first at Paris, and some time afterwards at London—houses for the importation of rubber, which at that time was most important commercially as the industry itself was in its infancy.

The basin of the Amazon produced about one thousand tons annually. In those days there were no telegraph cables, and as soon as a steamer carrying one hundred tons arrived at Liverpool the price, which varied from three francs to four francs per kilo, suddenly dropped.

At that time the output of the island of Java equalled that of Brazil. Since the island of Java has seen its stock of natural rubber depleted it only awaits the actual setting down of rubber plantations for the Port of Batavia to become an important future centre for the exportation of rubber.

Up to the present date Brazil has shown itself to be the most important producer, and till quite recently had half of the entire world's production.

The tables below show the increase in volume of Para during nearly half a century :—

EXPORTATIONS OF PARA RUBBER.

		Prices in Francs.				Prices in Francs.	
	Tons.	Lowest.	Highest.		Tons.	Lowest.	Highest.
1863	2,890	5.10	5.85	1887	15,600	8.05	9.55
1864	3,495	4.25	5.20	1888	15,900	7.90	9.10
1865	3,695	4.15	7.35	1889	15,500	7.10	8.50
1866	4,160	4.50	8.50	1890	16,900	7.80	11.25
1867	4,300	4.50	6.55	1891	18,400	7.10	10.35
1868	4,785	5.15	6.90	1892	18,990	7.35	8.25
1869	5,210	5.85	9.35	1893	19,730	7.80	9.30
1870	4,725	7.35	10.10	1894	19,500	7.65	8.75
1871	5,650	7.35	8.40	1895	20,710	8.40	9.40
1872	5,050	6.45	8.60	1896	21,600	8.40	10.35
1873	6,380	6.65	8.25	1897	22,700	9.40	10.10
1874	6,400	6.00	7.35	1898	22,000	9.65	12.15
1875	6,800	5.75	6.65	1899	25,300	10.80	12.85
1876	6,540	6.00	6.55	1900	26,876	10.20	13.20
1877	7,670	5.40	6.35	1901	30,300	9.10	11.10
1878	7,880	4.60	5.70	1902	28,530	7.90	10.55
1879	7,870	5.50	11.00	1903	31,120	8.00	10.80
1880	8,450	7.35	10.35	1904	30,400	10.70	14.75
1881	9,450	8.45	10.35	1905	34,450	13.10	15.75
1882	9,900	9.55	13.55	1906	34,600	13.70	14.75
1883	11,130	10.70	12.85	1907	37,520	8.60	14.70
1884	11,900	5.50	10.90	1908	38,240	7.60	15.05
1885	12,700	6.00	7.45	1909	38,915	13.20	24.05
1886	13,300	6.90	9.65	1910	38,030	34.55	15.95

One can see from the above table that during this period of fifty years the lowest price of fine Para was nearly four francs and the highest, that of last year, 34.55 francs, which, perhaps, this generation will never see again.

Fine Para has not only remained the principal kind of rubber but also the quality most esteemed.

If the plantation rubber is often quoted dearer than fine Para, it must not be forgotten that the latter contains nearly 20 per cent. of impurities, while the former can be practically all used by the manufacturer without any waste.

Besides fine Para, other sorts originating from Brazil, such as "negro heads," or "sernamby," *i.e.*, waste produced in the making of fine Para, which itself is carefully gathered and smoked like a ham, as well as the rubbers from Peru, Equateur, and Colombia, furnish equally excellent qualities which are often mixed with fine Para itself.

Brazil produces, in addition, two qualities : the one, white and damp, called Mangabeira, which is collected from a tree of the same name ; the other, Manicoba, or Ceara, which comes from a tree of another family. They are both consumed on a large scale.

The rubber industry in the basin of the Amazon has hardly undergone any modifications since its inception.

Notwithstanding the fact that Para or Manaos receive every minute cables giving the least fluctuation in prices, or if business is done just the same as in New York or Liverpool, or that Iquitos receives information by wireless, in the interior, the methods are still the most primitive.

The exploitation areas, or *estradas*, are in the hands of the principal towns (Para, Manaos, Iquitos, etc.). The labourers, or *seringueros* come from the State of Ceara. These latter get money or merchandise (*aviamento*) in advance, and it is only at the end of a year, when the gathering is finished, that the commission agent, a veritable banker, receives the equivalent of his advances in rubber. A high interest is levied on these advances, and in years of crisis, when violent fluctuations take place, there are numerous defaulters.

Although the United States use the most fine Para, it is London that regulates the price. The *raison d'etre* of this is that London is the banker of the whole world for rubber, as for many other articles, and besides this, the market is open and the offers and demands can make themselves manifest at any time during the day.

However, this Para rubber dealt in at London is generally warehoused at Liverpool, which shows, as the immortal Figaro says of Beaumarchais, that it is not necessary to have goods to deal in them. For this reason, a certain number of people who deal in fine Para, but who have never seen a case in their lives, are called here "outside speculators."

It is for financial reasons, also, that London has become the headquarters of plantation rubber of which the exploitation has been so successful.

The plantation rubbers are sold every fifteen days by public auction, which does not hinder large quantities being sold in the open market.

Liverpool still remains the market for gums from the west coast of Africa and for certain kinds from Brazil. The rubber is also sold by auction, as well as in the open market, which is the common method in France, and, above all, in Hamburg, which has become the most important port for African sorts on account of the considerable trade of Germany.

Antwerp has become the general port for gums from the Congo, through the influence of the gigantic work of King Leopold II., this State having become a colony of Belgium, after having been an independent State. The sales take place under form of sealed tender, a method of transacting business with regard to which there may be differences of opinion, but which the Belgians have borrowed from the Dutch, who in their turn found the origin in the customs of the Hague in the middle ages. There is nothing new under the sun.

I would have liked to discuss at length the wild rubbers which come from the French colonies, but aside from the fact that you will have an opportunity of hearing savants who will speak to you with great authority, I am not able to give to this subject the time it merits, even from a commercial point of view.

Who are interested in this question I would refer to a paper I prepared at the Colonial Office at Paris which has appeared in the periodical publications of this body. It suffices for me to say that the production of raw rubber in the French colonies has followed as one may say, step for step, the French conquests, outside of Europe.

Certain of these conquests seem to us to be doubted, for the rubber of the Casamance (a French colony) is called at Liverpool after the name of the neighbouring English colony, Gambia, and this name, Gambia, has even remained in the French market.

In the same way they have the name "Sierra Leone" for the rubber of the French Soudan and "New Guinea" for that of New Caledonia.

I hope that veritable *entente cordiale* will be established by which the rubbers of the French colonies will be given back their original names without bringing as a result any "delimitation" of their commercial interest.

"Factors Affecting the Valuation of Rubber Shares."

By Mr. W. TINNOCK.

On Friday, July 14th, Mr. W. A. TINNOCK delivered a lecture on "Factors Affecting the Valuation of Rubber Shares." Mr. D. S. Hunter presided.

The CHAIRMAN: I have been asked by Mr. Manders to take the chair, and I have to introduce to you a fellow journalist whose work has commanded the respect and admiration of a very large body of home investors, as well as a good many continental ones. Mr. Tinnock's subject is obviously a large one, but he will do his best to confine his remarks to the essential factors which may be said to affect the values of rubber shares regarded, of course, from the standpoint of the investor.

Mr. TINNOCK then read his paper as follows:—Now that the madness of the rubber boom has passed, the question anxiously exercising the minds of plantation rubber shareholders is, What is the value of my rubber shares? I can only touch on the fringe of the subject, and briefly indicate some of the many important factors operating which affect the valuation of rubber shares. Plantations cannot be classified into groups of which we can rest assured that all its members will always behave in a similar way. Where there is no uniformity of basic conditions, there can be no uniformity of results. Hence, rubber cultivation can never become the exact science which some of its statistical votaries would have us believe. It is not a question of merely planting trees, and trusting Nature to do the rest. Soil conditions count for something, and virgin soil, on which catch crops have never been sown, is undoubtedly the best. Those who have watched the development of the various estates notice that growth has been quickest on the undulating and self-drained alluvial deposits near the various rivers which skirt Province Wellesley and the States of Perak, Selangor and Negri Sembilan. A few plantations originally devoted to the cultivation of coffee are furnishing magnificent yields, but these are due to the natural richness of the soil. Selangor undoubtedly possesses the finest rubber land, and Kapar is perhaps the best district in Selangor. In Negri Sembilan there are some famous estates. Seremban, Linggi, Anglo-Malay and Consolidated Malay, which rival the gems which stud the Klang district. Again, in Perak, in the neighbourhood of Teluk Anson, there are several States developing magnificent growth, such as Cicely. This characteristic of virgin soil also distinguishes Sumatra, but is wanting in Java, where centuries of cultivation with varied crops of sugar, tobacco, cinchona, or tea have impaired the natural fertility of the soil. Companies whose rubber is planted on exhausted tea, cocoa, and coffee lands in Ceylon. or exhausted tapioca lands in Province Wellesley, and elsewhere, or on Sumatran coffee lands, which have been ravaged by disease, can never

be expected to give high yields. The unique advantage of virgin soil is also claimed for British North Borneo. This feature must thus constitute a modifying factor in all share valuations. It is not so much the exact constituents of the soil, as its ability to retain sufficient moisture all the year round, that is essential.

Even more important than soil are climatic conditions. *Hevea* thrives best where weather conditions present the monotonous regularity which prevails over large areas of the Federated Malay States and Sumatra, the constant alternation of hot sunshine and tropical showers, free from extremes of cold at night and seasons of drought, the presence of constant humidity in its atmosphere, which has caused Malaya to be described as a land of perpetual spring. In hilly districts where the temperature falls considerably during the night, the tree fails to flourish. Undulating land is preferable to flat land. The former shows less susceptibility to the effects of droughts, and favours of growth of strong tap roots. On flat and hilly lands little difference arises either in latex yield or growth. On bukit lands the trees offer better resistance to wind-storms, owing to larger and stronger tap root. Flat lands are good in so far as they retain moisture, but unless well drained, the ground gets sodden with water, the roots lose their hold, and trees are apt to fall down. Nearly all the older estates, as you will have observed in recent reports, have been losing trees from bad drainage. Hence, plantations that have drained and are draining their flat lands will be in a much stronger position than where the management, intent on bringing the plantation into bearing at a low cost, has neglected to provide efficient drainage. Low-lying lands will have heavier weeding expenses to face, for excessive dampness of soil is naturally accompanied by rank growth of weeds. This factor may form a permanent handicap in its incidence on the cost of production.

Then there is the question of catch crops. Few estates have been better off for catch crops. The practice is being gradually abandoned. They form attractive features in prospectuses, holding out hopes of interim dividends, and lessened cost of bringing the estate to the producing stage. A few isolated examples can be given where catch crops have appeared to pay. Coffee robusta, when sown at proper intervals, has proved the most reliable. Its advocates claim that while revenue producing it at the same time keeps down the growth of weeds, and therefore, of course, lessens the cost of weeding. Land having undergone prior cultivation with coffee is always freer from pests than virgin jungle, owing to the clearance of all dead timber. Sugar has proved an excellent catch crop in the past. Its prior cultivation has resulted in the cleaning away of all dead roots and jungle growths, bringing about an immunity from fungoid growths. The rubber has shown good growth afterwards, to which no doubt the thorough acration of soil by the cultivation of sugar has largely contributed. Tapioca is anathema to all good planters, as it is exhausting to the soil, and seriously retards the growth of rubber. Two of the latest to abandon it are Batang Malaka and Merlimau. Any revenue derived has proved poor compensation for the loss resulting from the rubber not having arrived at maturity, while the commodity has been realising high prices. The cost of uprooting has also proved heavy, while lalang springs up profusely immediately afterwards. Many estates have cultivated pineapples as a catch crop. Estimated rubber outputs have, in every instance, failed to materialise, and the folly of the step is now admitted. This planting of catch crops has then considerably modified estate valuations.

Clean weeding is another important factor. Great superiority on the ground of economy was for a time claimed for cover plants. Merton and Glenshiel both experimented with passion flower with a view to reduce expenditure for weeding. When the time has arrived for cleaning up the estates, the cost of eradication has proved heavier than anticipated while it has proved quite ineffectual as a safeguard against lalang, which has gained a firm footing. The use of benevolents are likely to prove costly failures. Either additional capital has had to be raised, or dividends have suffered, and clean weeding has to be undertaken in the end. Clean weeding is being neglected on many estates under various specious pretexts, although experience has invariably proved that the course is cheapest in the long run. When comparing two estates this factor will materially affect the valuation. Even a perfectly clean weeded estate may not prove immune from pest troubles. Everything depends on vigilant supervision. Let prunings and dead branches accumulate on the ground uncleared, and nectria may supervene. There are thousands of acres of young plantations which are still not clean weeded ; in which the soil is sour, the land has never been drained, and lalang is running in riotous profusion over the reserve lands. And the danger of lalang is that fire runs through it. The Serangoon is a recent example. How can these estates be valued on the same lines as clean weeded properties with well drained areas free from lalang ? A prominent feature in the expenditure of many companies recently has been the very great expense caused by thoroughly clearing the estates, that is removing all the dead timber and rooting up the stumps of dead trees. Allow these to remain and congenial spots are left for fomes and white ants.

The cost of opening up some of the large estates possessing large areas of land may be revolutionised by the use of the mule-drawn plough and harrow system now adopted by several large Malacca estates. The advocates of the system claim that its adoption will reduce the labour force required for working an estate of 2,000 acres to some 64 or 74 men, for the purposes of weeding and making roads and drains, in place of the 600 to 700 now required. Where hand labour is employed this method will ensure great economies, and its introduction on estates suffering from labour shortage for tapping would immediately relieve the situation by releasing coolies for that purpose. If the system fulfils all that is claimed for it the reduction in the cost of cultivating flat lands will be considerable.

Another important factor is labour. The general opinion is that Tamil labour is the best and cheapest, and, of course, the object of nearly every manager is to obtain a settled and permanent Tamil labour force. Estates dependent on local labour may find them wanting exactly when their services are most needed. The unprecedented development of rubber cultivation has raised the rates for European supervision, and for native labour of every description. Labour is now 30 to 50 per cent. dearer than seven years ago, with little hope of rates going down. As conditions become more civilised, and the people get more in touch with the luxuries of civilisation, there is little doubt it will be found increasingly difficult to keep down the cost of labour. This is inevitably the case. This will, of course, constitute a further big handicap for the new companies against the old producers. The abolition of indentured labour has on the whole proved a great blessing. It has brought about a substantial influx of Indian labourers. The number of Kangary coolies entering in 1909 was 24,568. In 1910, 58,615, and for 1911 will probably

reach 100,000. The old Klang estates, like Bukit Rajah, Batu Caves, Seafield, and Vallambrosa, with their permanent and settled Tamil labour force, possess a great advantage over estates in parts of Negri Sembilan, Malacca, and Johore, at the present time compelled to rely largely on Chinese labour, which is proving not only expensive, but in many cases unsatisfactory. This will seriously affect the cost of production, and estates in districts employing this labour will probably fail for some time to bring their cost of production down to the level of the famous estates of Selangor. A goodly proportion of Chinese labour is also employed on a few Selangor estates in the Kajang district, hence the cost of labour on an estate like Inch Kenneth is always likely to be in excess of that on one like Federated Selangor. The young estates will have to pay heavily for labour, especially where big planting programmes are in contemplation. The work of opening up land is extremely unhealthy, and the coolie loves a healthy estate. This is only natural. Death is no more welcome in the East than in the West, and as Dr. Watson observes in his recent work on the prevention of malaria, the main labour problem is nothing but the malaria problem, and the solution of the malaria problem will also be the solution of the labour problem. No estate, he says, can even have an assured labour force where the women wail. We cannot have children here, and the children we bring with us die. There is no more valuable asset than a contented and permanent labour force well housed, and proper regard paid to their habits, customs and religion. Hence well-built coolie lines, the presence of a sacred cave, like that at Batu Caves, or a temple on the estate, like Sengat, constitutes a great attraction. Labour is largely a personal question. The coolie is quick to appreciate justice and kind and considerate treatment. Where difficulties continually arise with labour, the shares of the company should be avoided, for management is at fault.

Another valuable asset is an abundant supply of good water, which is essential, both for the manufacture of rubber as well as the health of the labour force. Transport is another operating factor. The cost will vary greatly. Take an inaccessible hillside estate in Pahang, situated at a long distance from the railway, and far from any good roads. How can such an estate's costs compare with those of one flanked by a splendid main road, or possessing a railway station in its midst, or within close proximity to Port Swettenham, Teluk Anson, Penang, or Singapore? And then, again, there are the transport facilities on the estate. Some plantations cover extensive stretches of country, and companies that are constructing bridges over the rivers and streams, gravelling and metalling their roads, filling up their swamps, and draining their reserve areas out of present revenues, must be valued on different lines from those that have all these problems still to face. This is where some of the old producers will come out with flying colours.

Then we come to the manufacture of rubber. When annual outputs run into big figures, and rubber falls to 2s. 6d. per lb., differences of 3d. to 6d. in the prices realised will be a serious item. This will make an enormous difference in the dividends. Companies now having a reputation for the best brands have a magnificent start. Those with a bad reputation, through neglect to provide the proper machinery and take the proper care at the outset, will find it difficult to obtain the best prices in future. Then there is the question of reserve areas. A reserve area is a big potential asset to a company whose shares command a high premium. Where new capital can be raised for this purpose, by issuing shares at £3 to £10 premium an acre of rubber can be brought

into bearing at one-fourth to one-eleventh the cost, where fresh capital can only be raised at par. Sagga last year issued new £1 shares at £9 5s. premium; and Kuala Selangor 2s. shares at over 20s. premium. Where a new company can bring an acre of rubber into bearing for £60, Sagga and Kuala Selangor can do the same for less than £6. Where the new company can earn 10 per cent. the old producer can earn 100 per cent. Hence the capitalisation per acre of some of the older companies may fall still lower, while that of the newer concerns will steadily rise.

Another important point is that of onerous agency conditions which have been fastened on many of last year's companies. How burdensome agency conditions can become was pointed out in the case of Jugra, though in this instance the remuneration was thoroughly deserved for valuable services rendered. In some new flotations these payments have been exceedingly burdensome. They are the only persons who profited by the flotation, and the only individuals who will benefit by the continued existence of the company when rubber falls to low prices. The size of estates has a bearing on estate valuation. The ideals for economical management are compact areas, like Selangor, Pataling, Batu Caves, Seafield, Sungei Way, and Damansara, comprising 2,000 to 2,500 acres, which can be supervised and well controlled by one able man. On big estates organisation becomes necessary. This speedily eats into working expenses. Agriculture cannot be directed by counting house methods. To assure success, personal vigilant supervision of every detail is essential. Scattered estates, again, mean expensive management, through duplication of buildings and staff. Then there is the question of organisation of estate work in detail, the splitting up the estate into blocks, and the constant comparison of progress, working costs and other particulars on each block. Economical expenditure is of vital importance. Huge profits are being made, and the extravagance on some of the newer estates is appalling. Every item of expense requires close scrutiny. This is the secret of the low cost of production on some estates. Experienced planting directors prefer Ceylon managers for this reason. The margin of profit on tea cultivation has been very small. Large crops have had to be handled, with attention concentrated on the keeping down of every item of cost, and exercising care in every detail.

Yet another important factor to take into account is the possession of a Board of Directors with personal experience of the vicissitudes of tropical agriculture. Those who have passed through the mill, best know and can best appreciate the difficulties of the honest manager, who will wait week after week for a successful burn, who will not hesitate if labour is short to throw over the extension programme to keep existing areas clean weeded, who refuses to tap trees till they are ripe for tapping and an efficient tapping force has been carefully trained under personal supervision. Many new companies are under the charge of incapables, men fresh from home, destitute of preliminary training, unskilled in planting, without acquaintance of the native languages, inexperienced in the management of labour, and without any proper sense of their responsibilities. Rubber valuations made without real knowledge of an estate, and its management are of little service. Something more is required than a comparison obtained from multiplying the number of planted acres by the quotations at which shares stand. Many calculations of this kind are made. As pointed out before, in some instances assumptions are made that hundreds and thousands of acres can be brought to the productive stage without incurring expense, that there are neither buildings, bungalows, nor hospitals to be erected; no

factories to be built and equipped with machinery ; that neither paths nor roads nor transport facilities have to be created ; that there are no swamps to be drained, and that immature areas will provide for their own upkeep.

I have drawn up a table showing the earning capacities of a few well-known companies when in full bearing :—

	Planted Area. acres.	Output per acre. lbs.	Total output. lbs.	Profit per lb.	Total Profit.	Earning capacity.	Capitalised value 10%
Anglo Malay ..	4,168	600	2,501,800	1s.	£125,090	85%	17s.
Bukit Rajah ..	3,050	600	1,830,000	1s.	£91,500	137%	£13 14s.
Cicely	839	600	497,400	1s.	£24,870	155%	31s.
Damansara ..	1,884	600	1,130,400	1s.	£56,502	54%	£5 8s.
Golconda ..	1,170	600	702,000	1s.	£351,000	50%	£5
Inch Kenneth ..	1,404	600	842,400	1s.	£42,620	140%	£14
North Hammock	2,500	600	1,500,000	1s.	£75,000	75%	£7 10s.
Sumatra Para ..	2,400	600	1,440,000	1s.	£72,000	72%	£7 4s.

This ought to reassure rubber investors that the industry is on a very sound basis. In the case of the newer companies the problem is, of course, to arrive at the ultimate capital expenditure. Companies that are meeting all outlays out of revenue are building up a splendid position. Every penny put back into the estate is helping to form a reserve against future contingencies. New estates will never be brought to the bearing stage so cheaply as the old producers. How the cost of upkeep where properly maintained is steadily rising will be realised from the following examples. At the Lanadron meeting attention was directed to the fact that the cost of development had increased during 1910 to £12 4s. 8d. per acre, against £10 5s. 6d. for the previous year. This result was only arrived at after deducting an important item of £5,136, representing expenditure on the construction of a road from the Jementah estate to the railway. The cost per acre, then, over two years has worked out at considerably over £23, and there appears little chance of reduction. It is recognised that if high yields are eventually to be obtained, the greatest attention must be concentrated on plant sanitation, which, though expensive during the early stages, pays well in the end. Golconda was a model promotion. The estate is situated in the heart of one of the best districts of Selangor. The management has been in the hands of a band of practical planters with a life-long experience in Ceylon, and a training which leads to the closest scrutiny of all details of expenditure, and is calculated to develop to the utmost the organising capacities. The rubber growth has exceeded all anticipations. The estate has reached maturity considerably ahead of expectations. Additional capital has been obtained by the issue of further shares at a considerable premium. Yet, at the end of 1909 the capitalisation per acre was in the neighbourhood of £70. The working costs on Strathmore, another company whose management is keen on an economical policy, works out at nearly £4 per acre for the second six months of 1910, and Ulu Buloh at over that figure.

Another important point is the ultimate yield. There have been optimists abroad who have looked forward to yield of the estates of 1,000 lbs. per acre. Others regard 300 to 400 lbs. as the more likely maximum. In the case of the best estates let me bring forward a few facts of the optimists. On Seremban, one of the show estates of Malaya, during 1910, 304,620 lbs. were obtained from 350 acres of rubber planted in 1898, or the high average yield of 810 lbs. per acre, while a younger

field of 83 acres, planted in 1903, gave a yield of 572 lbs. per acre. On Inch Kenneth, again, some of the oldest trees, dating back from 1896, are each returning a yearly yield of 20 lbs. of rubber, and this in spite of ill-usage during a portion of the time, so great is the fertility of the soil. On Seafield, again, although closely planted, 200 acres planted in 1904 are yielding 400 lbs. per acre. On Kuala Lumpur there are trees 14 years old which gave an average of 10½ lbs. for last year. Kamuning, the Linggi offshoot, can boast of some giants freely yielding 20 lbs. of latex a year; Cicely is yielding 8 lbs. per tree on trees of ten to twelve years old; while Vallambrosa perhaps takes the palm with seven trees said to be yielding 1 lb. of rubber every other day. And many other examples of individual large yields over both small and large areas can be mentioned which will buoy up the hopes of the optimist. Hence, where soil and climatic conditions are highly favourable, and management excellent, and plant sanitation well cared for, 600 lbs. per acre may not prove unduly optimistic.

There is another factor alarming many investors: that is synthetic rubber, but I do not think the shareholder who has his money in moderately capitalised companies need greatly fear synthetic rubber; for there are no materials which, when used for manufacture on a large scale, will not rise rapidly in price. These laboratory experiments are interesting, but nearly all existing patents are on the same lines, and I do not believe that it will ever be found possible to manufacture isoprene based caoutchouc to compete with natural rubber. If, in the height of enthusiasm, without foreseeing any of the difficulties which may attend manufacture on a large scale, the cost is estimated at 10d. per lb., by the time a manufacturer's profit is earned and the article is marketed the cost will amount to 2s. to 2s. 6d. for an inferior article. Plantation rubber is, at the present moment, being turned out on several plantations cheaper than this crude substitute. Investors need not then be alarmed. The scientist, in his enthusiasm, is always apt to overlook the stern limitations which business and finance impose. The analytical chemist in his laboratory can work marvels. He can determine with exact precision the constituents which make up a substance, and then, by bringing them together again from other sources, can manufacture a similar article, not distinguishable, so far as chemical composition is concerned, from the original. But there is a limit to his skill. He cannot unravel all the secrets of Nature. His work lacks her perfection, and is therefore inferior to the finished product in commercial utility. This is because he cannot reproduce in his laboratory that delicate and complicated balance of the forces of Nature which result from soil, seasons, and atmospheric conditions, and which, in the case of natural rubber, largely determine its essential qualities.

How, then, can we arrive at a fair and conservative valuation of the ultimate valuation of rubber estates? A simple plan, presuming the capital account is closed, is to take the planted area, assume a maximum yield per acre of 300, 400, 500, or 600 lbs., according to the individual circumstances. Then calculate the profit at 1s. per lb. Divide this by the capital, and the earning capacity is arrived at. Capitalise this at 10 per cent., and you will get a fair valuation of the ultimate value of a rubber share.

It will be grasped that rubber valuation is full of complexities, and that among the principal factors operating to modify purely statistical calculations are quality and character of the soil, climatic conditions, lay of the land, drainage, catch crops, clean weeding, the clearing away

of all timber, and uprooting of dead stumps, the manner of cultivation, labour conditions, water supply, health conditions, the possession of reserves and power of financing them at low cost, transport conditions on and off the estate, the manufacture of rubber and quality of the brand, agency conditions, management at home and on the estate, and finally, conservative methods of finance. And these by no means exhaust the list.

The CHAIRMAN : You have heard this very excellent and informative paper, and I am sorry there is not time to discuss it at length owing to the fact that Sir Henry Blake is about to distribute the awards, but we have a few moments of which use might be made.

Mr. WALTER FOX : I should like to say a few words with reference to the interesting paper we have just heard. The lecturer started by speaking of the soil, and very rightly said that the richest soil no doubt produced the best results. It helps good cultivation. In some parts of the Malay Peninsula there are what are known as coastal districts which have very rich soil, and there the growth is phenomenal, but this part of the peninsula forms a very small part of the whole. The predominating soil is what might be termed loam. The point I wish to mention is that soil as regards the three great factors of heat, moisture and soil is of the smallest consequence. I have seen *Hevea* growing almost in sand. I have seen it growing amongst stones, and age for age that grown in rich soils compared with that grown in poor soils, would be better. I have also seen excellent results from trees grown on the most impoverished soil. In Penang there is a road which was formerly planted with coconut trees. It is possibly not more than a mile from the sea. Geologically it is a very recent formation, and nearly all sand, with just a little soil on the top, yet here I have seen *Hevea* growing very well indeed. So that in taking into consideration the investors' point of view, the effect of soil is not so important as the equable distribution of heat and moisture. These are the two prime factors of the three important essentials. With regard to tapioca and catch crops, that I cannot gainsay, yet I have seen rubber trees planted in tapioca which have done really well. The reason is that *Hevea* has such a wonderful vitality that it will surmount remarkable drawbacks. It has a really wonderful vitality. Its success amongst tapioca is specially seen in the Province of Caledonia, where they allow the Chinese squatters to cut down the jungle and plant tapioca and *Hevea*. I have walked over there and have been astonished at the success of the rubber. Then there is the problem of clean weeding. I know there are plenty of planters who do not believe in it, and others who do. Of course, there is a difference of view as to what is clean weeding. In the kinematograph you see a floor without any vegetation, and only a few weeds here and there. That is what I mean by clean weeding, but to say that that is better for the tree than to leave the weeds, I cannot agree. I have spent my life in tropical agriculture, and I say it is not so. It is better to leave the weeds for a time and then dig them in. You then get a certain amount of humour, you get the soil aerated, and you get the benefits of the mulch. In point of labour the lecturer referred to Johore and one or two other places as employing Chinese labour. There is no earthly reason why they should not employ Tamil labour just as in Selangor and other places. They have the same facilities, and it is just as easy for them to take their applications to the superintendent of immigrants or follow in the usual method of recruiting. I allude to the estates extensions

from Singapore on the one hand to Penang on the other. They are all equal in that respect, and there is no reason why they should not have all the labour they want.

The CHAIRMAN: There is just one point I should like to put to the lecturer. He has given a very interesting account of the large companies, but it often happens that one wishes to come forward in a small way with enterprise. We know you want sufficient capital, experience and reasonable management, but if the lecturer, with his wide experience, could tell us whether there are any special reasons why small planters should not succeed it would be interesting. Take the Malay States, for instance, whether there is any district suitable for small planters.

Mr. TINNOCK: You have raised an important point, and I cannot go into it at length. No doubt many of the estates commenced with a small capital have done remarkably well. When you come to cultivate large estates, organisation is necessary, and the increased cost of management eats largely into the profits. There is not the same percentage of profits on the large estates as on an individually well-managed estate.

The CHAIRMAN: I may say that I was talking to one of the Malay representatives with regard to the prospects of an individual going out to the East to undertake planting, and I was told there was a distinct opening out there for competent men with capital to take up 2,000 or 3,000 acres and to undertake mixed planting.

Mr. ERNEST SALMON: I should like to ask one question. Mr. Tinnock referred to 1s. per lb. profit, and works out the dividend that would be paid on that basis. Does he mean 1s. per lb. profit on this year's basis or on the production of the next ten years? because a company like the Chersonese will be producing in ten years' time ten times as much.

Mr. TINNOCK: The calculations were based on the planted area at the present time. A maximum output of 600 lbs. per acre is assumed when the whole of the planted area arrives at maturity, and the profit is taken at 1s. per lb. net.

Mr. SALMON: Then the 1s. per lb. basis is not one that applies to the present year?

Mr. TINNOCK: Not at all. I have only now to thank you for the kindness with which you have listened to me.

CHAPTER VI.

A Meeting of the India Rubber Testing Committee.

Meeting of the India Rubber Testing Committee.

The Programme given below was Circulated among the Members of the Conference before the Meeting.

(General Scheme).

The President will welcome the members of the various National Sections and will deliver a short address, in which he will refer to the origin of the Committee and the scope and nature of the work. He will then call upon the secretaries of the various National Committees to give a brief *resume* of the work done and the data gathered by the various Committees.

The Conference will then proceed to discuss details of the various tests. The Conference will first consider various questions connected with the testing of crude rubber, and secondly the testing of manufactured rubber.

The various questions arising will be discussed in the following order :

CONFERENCE. (DETAILS).

I. Crude Rubber. II. Manufactured Rubber.

1. Crude Rubber.

(*a*). What constituents are to be determined, and what, if any, physical tests shall be applied ?
(*b*). Methods of determining constituents and recording analysis.
(*c*). Methods of physical testing.
(*d*). Vulcanization tests. How are these to be applied and is it desirable to have a standard method of washing, mixing, curing, &c.

(*A*). *CHEMICAL CONSTITUENTS.*

It is suggested that the following be considered :

1. Moisture.
2. Ash.
3. Nitrogen.
4. Insoluble Matter.
5. Resin.
6. Rubber.

(*A*). *Physical Tests.*

It is suggested that the following be considered :

1. Viscosity Tests.
2. Solubility Tests.
3. Colour Tests.
4. Adhesion Tests.
5. Tensile Tests.

(*B*). *METHODS OF DETERMINING CONSTITUENTS.*

Are the tests to be carried out on washed or unwashed samples ?

1. *Moisture.* (Direct by heat ; in a vacuum ; indirectly as part of resin estimation ; quantity of material ; sampling).
2. *Ash.* (Quantity of material ; method of incineration, &c.)
3. *Nitrogen.*
4. *Insoluble Matter.* (On dried or extracted sample ? Quantity of material ; direct or indirect solvents to be used ; determination of nitrogen, ash or both in soluble or insoluble part ?)
5. *Resin.* (Quantity of material ; time and solvent, &c.)
6. *Rubber.* By difference, or by a direct method (bromide, nitrosate, &c.).

(*B*). *Methods of Recording Analyses.*

1. Nitrogen as such or as proteid.
2. Where rubber by difference, how is this to be done (overlapping of nitrogen, ash and insoluble matter).

(*C*). *METHODS OF PHYSICAL TESTING.*

Viscosity—Solubility—Colour—Adhesion—Tensile tests.

(*D*). *VULCANIZATION TESTS.*

1. *Methods of Washing.*
2. *Method of Drying.* (Air or vacuum ; ordinary temperature or higher temperature.)
3. *Methods of Mixing and Calendering.* (Rubber and sulphur or complex mixture. Method of working rolls, etc. Method of calendering ; thickness of test piece.)
4. *Method of Curing.* (Live steam press, autoclave press. In moulds, rings, frames, wrapped or open.)

(II.) VULCANIZED RUBBER.

The following are suggested for consideration :

a. Mechanical tests (Tensile tests, abrasion tests, hardness tests, etc.).

b. Physical tests (heat tests, etc.).

c. Physico-chemical tests (action of re-agents, such as water, oil, alkali, acid, etc.).

d. Analyses.

(*A*). *MECHANICAL TESTS.*

1. *Nature of test pieces and methods of preparing them.*
2. *Tensile Tests.* (Methods of estimating strength and elongation ; intermediate loads ; repeated stretching tests ; loads at constant length ; length at constant loads, etc. General discussion on apparatus or machines that can be used. Hysteresis curves and their interpretation.)
3. *Abrasion Tests.*
4. *Hardness Tests.*
5. *Other Tests.*

(*B*). *PHYSICAL TESTS.*

1. *Heat Tests.*
2. *Effect of Light.*
3. *Permeability to gases.*
4. *Electrical Tests.*
5. *Other Tests.*

(*C*). *PHYSICO-CHEMICAL TESTS.*

Effect of reagents, such as water, oils, alkalis, acids, etc. Methods of carrying out these tests.

(*D*). *ANALYSIS.*

1. Estimation of Ash or Mineral Matter.
2. Estimation of acetone soluble substances.
3. Methods for extracting and determining Pitch, Bitumen and similar substances.
4. Saponification Test.
5. Methods for determining individual constituents.
6. Methods for determining Rubber direct or indirect.

The meeting of the India-Rubber Testing Committee was held on Thursday afternoon, July 6th, Dr. A. H. Berkhout, late Conservator of Forests, Java, presiding.

The CHAIRMAN said: Ladies and gentlemen, I cordially welcome all our members and visitors, among whom are scientists come from nearly every part of the world. In one of the conferences held in connection with the International Rubber Exhibition in London three years ago, the Chairman requested me to take the initiative in forming an international committee for testing rubber. I have now performed my task. There is a committee now, having sections in various countries, its members being: Herbert Wright, editor of the *India-Rubber Journal*, London, Mincing Lane House, 59, Eastcheap, Secretary; Dr. O. Warburg, Berlin W. Uhlandstrasse 175, Secretary; Pierre Breuil, 49, Rue des Vinaigriers, Paris, Secretary; H. C. Pearson, editor of the *India-Rubber World*, 395, Broadway, New York, Secretary; Dr. Herbst, Vienna XIII. 3, Secretary; Kelway Bamber, Government Analytical Chemist, Ceylon, Secretary; J. G. Fol, Chemical Engineer, Delft, Holland, Secretary. First of all, we shall have to attack the difficult problem of establishing standard methods. It is, of course, necessary we should agree in regard to the physical and chemical methods to be employed in testing india-rubber. It is not as it should be when a man can see the significance of his own figures but is not able to understand somebody else's. What we want is a uniform standard for testing rubber, and this will be beneficial to both planter and manufacturer.

I hope that our present conference may prove to be a first move in the right direction. Our task is a very difficult one, it is true, but our committee, including, as it does, so many experts and specialists, should be able to do good work. I am sure I express the sentiments of all our members and all the visitors assembled here, if I move a vote of thanks to the committee of the International Rubber Exhibition, which has enabled our committee to hold its first general conference here.

At the request of Dr. Berkhout, Dr. Schidrowitz took the chair.

Dr. SCHIDROWITZ: I am acting here entirely on behalf of, and as the moutpiece of Dr. Berkhout, President of the International Committee. This committee was formed three years ago, and consists of various national sections. Certain questions have to be discussed here, and while these propositions necessarily concern directly only the members of the committee and the various national sections, we equally welcome here visitors attending the General Conference, and shall be glad to hear their views on any general questions, not affecting the constitution of the committee, that may arise. Several proposals will be put forward, but it is not intended that votes should be taken here. Each national committee should record its vote at the earliest possible opportunity, and send the result to the President.

The first business of the meeting will be to hear the reports of the secretaries of the various national sections in regard to work accomplished in the past three years. That work has been, and was intended to be, of a purely preliminary character. It has been spade work, with a view of collecting data, in the hope that on the data so obtained, some rational system of tests, to which the various national sections will be able to agree (at least in regard to essential details) may be evolved. On behalf of our President, therefore, I now call upon the secretaries of the various committees to read their reports as to the work done. I think that the British Committee comes first alphabetically, and I will call on Mr. Herbert Wright.

Mr. HERBERT WRIGHT: I am sorry that I have no report to read. I can, however, give you some idea of the work undertaken by the committee during the past two or three years. In the first place I should mention that there are still several members who ought rightly to belong to the British section, and we hope that they will sooner or later come forward and allow us to put their names on the general working committee. At the present time we have Mr. G. C. Mandleberg, Mr. Leon Gaster, Mr. H. E. Potts, Dr. Schidrowitz, Prof. Schwartz, Dr. Spence, Mr. Francis Martin, Dr. Torrey, and Mr. S. C. Mote, in addition to myself. It is fairly representative, and includes members of the scientific, the manufacturing, and planting departments of our industry. During the year we issued a circular giving the objects of the International Rubber Testing Committee, and outlining four or five main points. These were: first, that we were concerned with collecting data with regard to the various official and unofficial chemical and other tests applied to raw rubber and manufactured articles; second, that we were concerned with a consideration of those tests from the point of view of efficiency and expediency; third, that we were to make recommendations regarding the desirabliity of maintaining, modifying, or abolishing existing methods of testing, and to suggest, if possible, new methods of working this out on a practical basis; fourth, that we were to act as an advisory body in cases of doubt or dispute, concerning methods of testing; and last, that we were, if desired, to act as a board of reference, or arbitration. These particulars were circulated amongst practically the whole of the manufacturers in the United Kingdom, and I am happy to be able to say that whilst it is impossible for obvious reasons to include the names of certain manufacturers on our list, we know we have their support, and only regret that we cannot use their names to show the strength of the various recommendations made. However, they are with us, and will act with us when the necessity arises. In addition, we have received an invitation from our friends of the American Chemical Society to transmit any remarks we may have to make upon the tests they recommend from time to time, and also to the effect that they would be glad to consider any methods which are approved by the whole of the various committees throughout the world. That, I hope, will prove a great benefit to us in years to come. Having done that, we thought it advisable to approach manufacturers and technologists in this country with a view to finding out some of their opinions in connection with tests to be applied first of all to crude rubber, secondly to vulcanised goods, thirdly to mechanical tests, fourthly to physical tests and lastly, chemical tests. We have received a number of replies from various manufacturers and technologists on these questions, but we have not, so far, made any use of them; and we propose to submit them to our President before we do so. In this matter I have a large amount of correspondence which shows strikingly the secrecy with which manufacturers generally regard their interests in this country. In one case our friends wishing to help us, posted the replies to the questions, but they went to an outlying district to post it, and did not even sign the document. To this day we do not know from whom it came, though we can make a very good guess. That gives you some idea of the work we have accomplished, and the data we have compiled in connection with the English section.

The CHAIRMAN: I should, alphabetically, have called upon America, but as a matter of fact Mr. Pearson is not here, having, unfortunately, been attacked by an affection of the eye. I do not know whether there

is any representative of the American section here; if so, we shall be glad to hear what has been done over there. If not, I will call upon Mr. Kelway Bamber to be good enough to speak as secretary for Ceylon.

Mr. KELWAY BAMBER: It has come rather as a surprise to me at the moment that anything was required from me on the work done in Ceylon, but I may say we have been conducting experiments which so far are very tentative, and although we are obtaining promising results, we cannot feel that any of them are worthy of publication until they have been confirmed over a considerable period. At the last Exhibition we wanted to obtain from the manufacturers some information as to the form in which they wished the rubber sent to England, but even at this Exhibition we are no further forward on that point than we were at that date, and although we are conducting experiments in tapping and having samples sent to England to be vulcanised and tested in every possible way so as to arrive at the best methods, I am afraid we have nothing definite at the moment to lay before you. The experiments are being continued, and we hope in time to be able to arrive at some definite conclusion, not only as to the best method of manufacture, but as to the effects of the various systems of tapping. I consider it premature to publish results obtained from tests made by one or two manufacturers. We have found considerable difficulty in getting tests made, and we feel it is hardly fair to manufacturers to ask them to carry out our tests, because although we have received every kindness and they have been done in a very thorough manner, each manufacturer, as the previous speaker said, has his own private mixtures, and he is not prepared to give them out to the public generally. Until we can obtain some more satisfactory method of getting tests made, perhaps, by several manufacturers, or by ourselves, with sufficient plant, I am afraid it will be very difficult to draw any reliable data from the results obtained; but I may say we are progressing, and things are fairly hopeful. For the present it would be very unwise to give you the data so far received.

M. PIERRE BREUIL, speaking for France, said: Three members of the French section are not able to come to the meeting, so nothing is left but for me to make some practical suggestions which I know are also the ideas of the members of the French Committee. As you all know, we do not meet together sufficiently often to exchange our ideas. I do not want to speak about methods of testing crude rubber, because I do not particularly understand the question, but I may be permitted to make a suggestion about tests to be carried out.

Dr. SCHIDROWITZ: Will you excuse my interrupting you, but what we wish is that you should give us some account of the work accomplished by your committee. The discussion on methods of testing and so on will come up later.

M. BREUIL said he had nothing at present to say on that point.

Prof. Dr. WARBURG (German section): We have tried to do what we could in this matter. The committee consists of Dr. Frank, of Berlin, Dr. Vize and Dr. Kuhleman. We meet together sometimes in Berlin, and our object has been to frame general rules. I would prefer that Dr. Frank gave you the details.

Dr. FRANK addressed the meeting in German.

Dr. HERBST (Austria) explained that there was delay in forming the committee, and said a few trials had been made for viscosity tests, and more would be made in the future.

Mr. J. G. FOL (Holland) said: The members of the Dutch Committee are Dr. A. H. Berkhout, late Conservator of Forests, Java, President, Wageninqen; Prof. Dr. S. Hoogenerff, Wasjenaar; Prof. Dr. G. van Herson, Jr., Technical University, Delft; J. Merens, Esq., partner in the firm of Messrs. Merens Brothers, Haarlem; J. Musly, Esq., partner in the firm of Messrs. Weise & Co., Rotterdam; A. Slingervoet Ramondt, Chem. Eng., Amsterdam; Dr. W. R. Tromp de Haas, Buitenzorg (Java); J. G. Fol, Chem. Eng., Delft, Secretary. It may not be unknown to you that as an immediate consequence of the institution of the International Rubber Testing Committee, and the attempts of the Dutch Sub-Committee, especially of Prof. Dr. G. van Herson and Prof. Dr. Hoogenerff, the Government Bureau for India-rubber Trade and Industry was founded by the Dutch Government at Delft on May 15th, 1910. Prof. van Herson, who was charged with the management and the installation of the Bureau, has given, in the special catalogue of the Dutch Section of this Rubber Exhibition, a short account of the purposes of the Bureau and of the lines along which it proposes to work. In the above-mentioned account the elaboration and application of the mechanical and physical testing methods are considered as the principal tasks of the Bureau. Besides, it will endeavour to trace the connection between the properties and the composition of both raw rubber and the manufactured articles made therefrom. The influence of the different manipulations of the raw rubber on the composition and properties has to be established, and last of all, the Bureau aspires to promote the trade in raw rubber by replacing, at least, partially, the present empirical methods by more scientific ones. I should like to add that the Government Bureau has been opened for the chemical analysis of raw rubber since February 1st, 1911, and from August 1st, 1911, chemical analyses of vulcanized rubber will be made by the Bureau. Then the mechanical tests of the finished product will follow, and lastly will come the study of the very difficult problem of the connection between the qualities of the finished product and those of the original material and the influence of the mode of working up.

The CHAIRMAN: We have heard the reports of the secretaries, and I have now pleasure in announcing to you that a new section is to be formed in Brazil. That is only right, because Brazil provides one-half of the whole of the world's supply of rubber. I understand that Dr. Huber has expressed himself as ready to undertake the duties of honorary secretary and of forming the section. We shall be glad to hear his views on the prospects.

Dr. HUBER: I shall be glad to do something for the International Committee in Brazil and to do something to bring about the better testing of rubber. We have at this morning's conference heard of rubber being sold as prima rubber which was not the real thing. I think the first duty of the Brazilian Government in this direction is to see that the right name is given to every kind of rubber, because the first thing we want to know is, where the rubber comes from and the kind of tree it comes from. It is true that in some countries it is impossible to answer these questions exactly, but in many cases it is known what tree produces the rubber. As every kind of tree produces a special kind of rubber it is necessary to give the proper name and to see that the proper name is put on all rubber exported. It should, therefore, be impressed on all Governments that that should be done. Of course, botanical identification should be completed by physical and chemical tests.

The CHAIRMAN: I am sure you have all listened with interest to what Dr. Huber has said. I think if the section in Brazil will occupy itself with classification it will be of the utmost value to the industry. Before proceeding to the special business I should like to say a word with regard to membership of the national sections. This appears to have been somewhat misunderstood, and I am afraid that in certain quarters views are prevalent to the effect that sections have in the past acted in such a way as to make themselves of an exclusive character. I may say that from the first nothing of the kind was intended. It was indicated clearly that the sections should equally consider the membership of anyone qualified, and I trust, therefore, that those gentlemen who have not come forward to assist the committees in their deliberations and whose time permits them to do so, will avail themselves of the general invitation which is now being issued on behalf of the committee as a whole. That concludes the general business and we now come to certain proposals which are to be made in regard to the future work of the committee. In the first place, there is a proposal to be made by the President, which refers more particularly to the overlapping of work. As you are aware, there is an International Association for examining technical materials and we as a committee consider that if it should prove practicable to prevent overlapping of their work—which many of you know is of great importance—by the work of our own committee it would be a most desirable object to obtain. The President will propose that a sub-committee consisting of the secretaries of the various national committees be appointed with a view of considering the practicability of assisting, or affiliating ourselves, without, I may say, losing our identity, with the International Association or some other similar association. The voting on this question will be by units; that is to say, each national section will record its vote as a unit. We have agreed that it is not practicable to carry out any voting here, and we hope, therefore, that the various sections will record their votes by sending them in to the President on this question as soon as possible. Meanwhile, we shall be glad to hear the views of any members of the committee present in regard to the proposed policy.

Professor HINRICHSEN addressed the meeting in German, and it was announced that he expressed his view in favour of the President's proposal.

Dr. FRANK also expressed thorough approval of the proposal.

Dr. SCHIDROWITZ: The President informs me he has received a letter from the Secretary of the French section, expressing approval of the formation of an International Association.

Mr. HERBERT WRIGHT: All I can say is that the English section has already been invited to become in some manner directly associated with the Chemical Society of America, a section of which is entirely devoted to the question of testing rubber and rubber goods, and I told them that I had no doubt we should be only too anxious to take advantage of the opportunity.

Dr. HERBST expressed a favourable view with regard to the proposal.

The PRESIDENT then formally moved that a sub-committee be appointed and Mr. HERBERT WRIGHT having seconded this, it was agreed to.

Dr. SCHIDROWITZ: With a view to the collection of literature and data, each member of the committee should forward to the President of the International Committee four copies of any paper that may appear dealing with any rubber subject, with a view to placing these copies

at the disposal of other members of the committee who may apply for them. I scarcely think there can be any objection to this because it can only be helpful. If anyone wishes to make any observations or suggestions we shall be glad to hear them.

Dr. Esch: Since the first Rubber Exhibition the German Committee has lost two of its members; I should, therefore, like to propose that Professor Hinrichsen be appointed.

Dr. Schidrowitz: I am afraid you are scarcely speaking to the motion, which is in connection with the collection of literature. With regard to the membership of the committee I made a statement that the intention from the start was that everyone interested in rubber who had claims to special knowledge in connection with manufacturing, cultivation or testing, should be equally considered for membership. The various national committees have entire liberty of action, but I should like to repeat that it is the intention that the committees should not be of an exclusive or partial character.

Mr. Fol: The copies should be not only for the use of members of the committee, but of all who wish to use them.

Dr. Schidrowitz: I think the suggestion made by Mr. Fol is an excellent one and it will be carefully considered. I beg to move formally that four copies of each communication published by members of the committee, or those outside who will be good enough to send them in, shall be forwarded to the President, and that the literature shall be available to the members of the committee and others who may be desirous of availing themselves of the information contained in them.

Mr. Herbert Wright: I beg to second that.

Dr. Schidrowitz: The voting on this question will take place as on the other question in the manner I have described.

We now come to the more detailed matter of the Conference, and you will see that the programme here is a very long one. We have considered the question of dealing with these various details at this Conference very carefully, and we have come to the conclusion that it will be practically impossible in the short time at our disposal to consider them with that care which would be required in order to arrive at any understanding. It is proposed, therefore, that the various points which are enumerated here on this programme be considered by each national committee separately, the opinions of the various individuals composing the committees to be gathered and collated into the opinion of that committee as a whole. When these replies have been gathered, a sufficient number of copies for each national committee are to be sent to the President, who will then forward to each national committee the opinion of the other committees. It is suggested that any point of principle, or of detail, in regard to testing, on which all of the committees are unanimously agreed, should thenceforth be considered as the official methods of the committee. If there is no unanimity on any point either of principle or detail such point shall be deferred for further consideration. I shall be now glad to hear the views of the members of the various national committees on this point.

Mr. Whalley: Is there to be any time limit?

Dr. Schidrowitz: We have not considered any time limit, but at the same time we think some sort of finality must be reached, and, therefore, we shall be glad to hear the opinions of members of the committee, and others as to the question of the time limit.

Mr. HERBERT WRIGHT: As a working basis, I propose that the time limit for the present be six months.

Dr. KUHLEMANN: I do not think that would be enough.

Mr. POTTS seconded the proposal.

Mr. KELWAY BAMBER: So far as I can gather we have not arrived at anything definite, and it will take some years before we can lay down any methods as a result of tests—I would suggest that the time limit be one year.

Mr. HERBERT WRIGHT: I will alter my resolution.

Dr. SCHIDROWITZ: Might I suggest that we should first of all consider questions of principle without going into details, and that the time limit be six months for that general consideration, and a further period to be given for the consideration of the methods themselves.

This was agreed to.

Dr. SCHIDROWITZ: The suggestion is that six months should be given for the consideration of points of principle, namely which constituents could be determined, whether physical methods as a whole are desirable, and if so, which methods. The same applies, of course, to vulcanised rubber. For this preliminary consideration the time limit is to be six months and the consideration of details shall be decided within a further six months.

Dr. SACHS spoke in German.

Dr. SCHIDROWITZ (interpreting): Dr. Sachs has pointed out that the tests which can be applied by the manufacturer must differ in point of view from the tests which will be applied by the planter or the merchant and he has also pointed out that a test which is applicable for a specific purpose to one class of rubber is not necessarily applicable to another. I think we shall all be agreed with regard to that. He also points out that the suggestions which have been made here are merely suggestions, first as to what constituents should be determined, and secondly how they should be determined. If the manufacturer desires a specific test he must make up his mind, at any rate, how he is going to carry out that test. The same applies to the planter and to the merchant. When we have agreed that certain tests are desirable, we do not say these tests can be applied in every instance always in the same way, but we do wish to know what tests are useful. We wish to have the opinions of the individual members of the committee on that point, and we further want to know how these tests are to be carried out. These are, therefore, questions of root principle, which have to be considered. They are really the A.B.C. of the whole question, but it took some time to evolve even the A.B.C. of language, although most of us who have gone through the ordinary course of education regard the A.B.C. as a very rudimentary matter. But we are occupied first with this A.B.C. I wish to come to some conclusion, as to how many letters there should be in the alphabet, and finally how these should be expressed. Perhaps my simile is not a good one, but I think perhaps you will understand what I mean. The motion before the meeting is that the various national committees shall consider first of all the questions of principle, and secondly questions of detail. Later on, if the committee agrees on these points, those principles and details will become the official methods of this committee, but it does not necessarily follow that these methods will be imperative on those who stand out of the committee. They will be at liberty to adopt them or not; we are merely striving to rid our-

selves of difficulties and not to make new ones, and I think that is the cardinal principle on which any committee must work. We shall be glad, therefore, to hear opinions on these questions of principle.

Dr. STERN: I suppose that nearly all the manufacturers, and people who have practical experience, would prefer physical tests to chemical ones, because the chemical tests do so very little. I am afraid I shock several of the chemists here. I am a chemist myself, but in my short experience of four years I have been convinced that chemical tests show very little and throw little light on the points we most wish to know about India-rubber goods, which is the chief point to interest manufacturers.

Mr. HERBERT WRIGHT: You do not suggest that chemical tests should be eliminated?

Dr. STERN: I do not mean that.

Mr. KELWAY BAMBER: My views co-incide with those of the last speaker, because, as far as I can see from the chemical analysis of rubber in the East, it is absolutely no guide as to what that rubber is going to be when it is vulcanised, and while I think chemistry is useful, and that it would be very useful to collect as many detailed figures as possible as to the composition of various rubbers prepared under different methods, I am quite of opinion that the final test rests with the manufacturer. We must do a considerable amount with physical tests as well as chemical before we can arrive at any conclusion. So far as I can see, what we have always considered is strong rubber. It is not by any means proved that the strongest rubber is strongest after vulcanisation, and in other cases what we have regarded as weak rubber, wanting in elasticity, has given good results after vulcanisation, so that up to the present we are quite in the dark as to what is required from the chemical point of view. I would like to suggest, if this is the time, adding to the list of those constituents that we should also estimate the proportion of acidity in the various rubbers, as in nine cases out of ten it is coagulated by the addition of various acids. At present there is an idea that any excess of acid has a marked influence on the future vulcanisation. So I think it would be as well to collect details as to the acids of the various samples.

Prof. WARBURG addressed the meeting in German.

Dr. SCHIDROWITZ (interpreting): Dr. Warburg has pointed out a very important matter, that it is for the manufacturer to say what he wishes to have. It is then for the producer to try and give it to him. That, again, emphasises the difference in the point of view. The manufacturer applies his own tests, and if they are unstaisfactory it is interesting to himself rather than to the planter. In deciding what rubber is satisfactory, the chemical tests are evidently of more importance than the physical tests. The physical tests, roughly, show you results and the chemical tests show you the causes of those results. We should be glad to hear more as to those tests which you think should be applied by the producer and manufacturer respectively.

Mr. HERBERT WRIGHT: With regard to the point that manufacturers should say what they want, and that producers must try to produce it, perhaps the manufacturers will tell us whether they will give us that information. It is to them mainly a commercial proposition. You submit material of all grades. They have their own chemists and buyers, and, generally speaking, manufacturers simply say "We know our business, please know yours."

Dr. Esch addressed the meeting in German.

Mr. Schidrowitz : I think I had better perhaps briefly translate to you Dr. Esch's remarks, as they are of great importance. He points out that modern plantation methods have produced such an approximation in appearance of different types of rubber that it is extremely difficult for a manufacturer to know with any certainty what he is getting. He points out, for instance, that these are so similar in appearance that it is impossible to judge which is which. He also points out that modern methods—in which I may say chemistry has played a considerable part—have produced Ceara with as little as 3 per cent. of resin. He draws attention to the fact that rubber when it is landed here is taken out of the cases and frequently repacked in larger cases, and that the original cases do not reach the manufacturer. He suggests that this should be discontinued. He goes so far as to suggest that it should be made illegal to describe as Hevea rubber that which is not Hevea rubber. I hardly think any special legislation is necessary, because a practice of that kind appears to be obviously a fraud under the common law of any nation. The suggestion which he further makes that possible legislation might be introduced with a view to prevent the repacking of rubber is a larger question, and one on which the merchants and brokers will, no doubt, like to be heard before anything is done. Undoubtedly there are difficulties—practical difficulties—in connection with such a suggestion. At the same time I do think it is of the greatest importance, not only to the plantation industry, but to all producers of raw rubber that rubber should be marked, or packed, in such a way, and reach the manufacturer in such a way, that he can have no doubt as to what the goods are which he is receiving.

Dr. Stern : It would be easy, after taking the rubber out of the original cases and inspecting it, to put it back again in the same cases.

Dr. F. Kuhlemann addressed the meeting in German.

Dr. Schidrowitz (interpreting) : Dr. Kuhlemann has pointed out that we have departed somewhat widely from the programme, and have been discussing questions of law which do not concern us. Well, I think that the discussion of marks and methods of marking has been most interesting. I think it is not well to carry that too far, but the suggestion which he makes is that we should ask members of the committee and others present to make suggestions regarding any further tests which should be included for consideration in this list as this is an excellent opportunity for gathering the opinion of a representative assembly on this question. I trust, therefore, as time is going on, that you will limit further discussion to this particular point.

Mr. Fol : I should like to suggest that there should be a method indicated of sampling rubber. I also suggest there should be a test of acidity.

Dr. Esch : Not only of acidity but of the acids present in the rubber. Some acids are harmless but others are not harmless, and therefore it is necessary to determine what kind of acids are present.

Mr. Martin : I suggest that the scheme should involve a statement as to acidity or alkalinity, because it is possible a rubber might be alkaline.

Dr. Schidrowitz : It has been suggested that instead of "acid" it should be "reaction." The voting on these points will be as I have already indicated.

Dr. KUHLEMANN addressed the meeting in German.

Dr. SCHIDROWIT : Dr. Kuhlemann suggests that after the various committees have considered the programme and sent in their replies, a meeting shall take place at a spot to be hereafter determined, for the discussion of the results. I think that is a valuable suggestion and I would add that it should be held within three months of the twelve months which has been agreed to.

Dr. KUHLEMANN suggested the meeting should be at Amsterdam.

This was agreed to.

Prof. HINRICHSEN : In conclusion, I would like to propose a vote of thanks to Prof. Berkhout for the great trouble he has taken in connection with the work of the committee for which he has acted as President and General Secretary.

This was carried with acclamation.

Prof. BERKHOUT : I thank you very much, and I wish to propose vote of thanks also to Dr. Schidrowitz.

Dr. ESCH seconded the resolution and it was carried unanimously.

The proceedings then terminated.

CHAPTER VII.

Opening and Closing Ceremonies.

Functions, Results of Competitions, &c., &c.

London Chamber of Commerce,
1, *Oxford Court, Cannon Street, E.C.*
27*th July*, 1911.

A. Staines Manders, Esq.,
75, *Chancery Lane, W.C.*

Dear Sir,—

It is my pleasant duty to inform you that the Rubber Growers' Association assembled in General Meeting have resolved to award the Gold Medal of the Association to you, in recognition of the services which you have rendered to the rubber industry in connection with your organisation of the International Rubber and Allied Trades Exhibition, 1911.

May I ask that you will favour me with an intimation whether this suggestion is agreeable to you.

With compliments,

I am, dear Sir,

Yours faithfully,

(*Signed*) C. Taylor, *Secretary.*
Rubber Growers' Association, London.

1, *Oxford Court, Cannon Street, E.C.*
10*th August*, 1911.

Dear Sir,—

At the General Meeting of the Rubber Growers' Association, held on the 27*th ulto., it was unanimously resolved to present the Gold Medal of the Association to you as a slight mark of the appreciation of all connected with the Association for your untiring energy which contributed so largely to the success of the Rubber Exhibition held last month.*

I understand from the Secretary that you were duly advised of this resolution, and I now have the pleasure to send you under Registered Post the Medal which I have just received from the Sculptor.

Yours faithfully,

(*Signed*) Richard Magor,
Chairman, Rubber Growers' Association.

A. Staines Manders, Esq.

MEDAL.

The following is the inscription on above :—

Awarded to
A. Staines Manders, Esq.,
Whose untiring energy contributed
so largely to the success of the
Rubber Exhibition, July, 1911.

The Press View.

SATURDAY, 24TH JUNE.

The "Press View" took place on Saturday, June 24th, and there was a large attendance of representatives of British and foreign journals. After viewing the exhibits, the guests were entertained at luncheon. Major Sanderson presided in the absence of Sir Henry A. Blake, who had been announced to take the chair.

The toast of "The King" having been duly honoured, the chairman announced that Mr. Manders had sent a telegram to the King, which would at once be read.

Mr. FITZ-GIBBON read the telegram as follows:—

"Sir Henry A. Blake, the President, and the management of the International Rubber and Allied Trades Exhibition, of which your Majesty is the Patron, the scientists, chemists and manufacturers coming from all parts of your Majesty's dominions, and the representatives of the numerous foreign governments who are officially taking part in the Exhibition, and who are assembled at the Press View at the Royal Agricultural Hall to-day, send you loyal and dutiful greetings. We most earnestly pray that you and your Royal Consort may live long and have a prosperous reign. Should your Majesty find time to visit the Exhibition it would give unbounded satisfaction."

The CHAIRMAN then proposed the toast of "Her Majesty the Queen, Queen Alexandra, and the other members of the Royal Family," which was also loyally honoured.

The CHAIRMAN then said: Ladies and gentlemen, I am not going to inflict a speech upon you to-day, but there is one toast we should not forget, and that is "The Press." The Press are always sympathetic when they know there is a good object in view. This Exhibition, I have no doubt, will prove to be a most interesting one not only to growers and manufacturers, but to—I may say—shareholders and the public generally. There are some very fine exhibits here; and no doubt, through the medium of the Press, the public will be able to know where to go and find the interesting objects. Now, I should like to divide the Press into two portions on this occasion, first the Rubber Press of the world, and to couple with it the names of Mr. Pfaff, of *The India Rubber World*, New York, and Mr. Springer, *Gummi-Zeitung*, Berlin, men well known in both cities for their interest in rubber. Then, secondly, I should like to drink the health of the Press of England—rather a big order—coupled with the name of Mr. Gilliland, of the *Daily Telegraph*. Gentlemen, I propose to you "good luck to the Press."

Mr. PFAFF: Gentlemen, I was only advised a few moments before I sat down, by your organising manager, that I might be called upon for a few remarks and it just dawned upon me at that time that before I left New York I asked the distinguished President of our Organisation if I might be called upon to speak. He said, "You may be." I said, "You know what an indifferent speaker I am." He replied, "I know that, but the people across the water are exceedingly polite and long-suffering, and do not expect much from a Yankee anyway." After these consoling remarks, I felt that if I was asked to say anything perhaps it would be forgiven and forgotten. But I do not mind confiding to you, gentlemen, that I am pretty fairly familiar with everything in the line of speech-making, except how to start and how to stop. It would be

futile for me to attempt to say anything about rubber, because I do not suppose there are many people here who are not more familiar with rubber than I am: but there are in the United States three kinds of rubber—rubber, near rubber, and almost rubber. I do not profess to know much about either of them, and I do not propose to inflict upon you anything I do not know. I want, however, to say a word about the disappointment experienced by Mr. Pearson in not being able to be here to-day. It had been a cherished hope of his for a number of months that he would have the pleasure of repeating the last very happy experience of three years ago, but owing to a slight indisposition he thought it would be better not to try it this time. It is unnecessary for me to make any remarks about the substitute he had to send. With regard to the Exhibition, I may say that there is not any doubt in the minds of any of us about the outcome of this Exhibition, as even at this early date it speaks for itself; but I do not suppose there will be any feature of it that will be pleasanter than this most delightful luncheon, which will linger in the memories of all of us as "up river, fine." (Applause.)

Mr. George Springer: I thank the Committee for the invitation to this luncheon, and I wish in the name of the Rubber Industry of the world, to express my satisfaction with all I have seen here. It is certainly the most important Exhibition of its kind that has taken place. (Hear, hear.) It will prove not only interesting but most instructive to all those who visit it, and enable them to understand and appreciate the high position which the industry has taken up in the world at large. (Applause.)

Mr. Gilliland: On behalf of the English Press, and more particularly on behalf of the Press of London, I wish to thank you for the kindly way in which you have received this toast. It gives us all great pleasure to come to these exhibitions; for although we may not be personally interested in rubber production, yet there is much to see and much to learn, and much that is intensely interesting. I saw the Exhibition in the making a week ago, and am astonished at the rapidity with which it has been brought to its present finished condition. In my tour of the exhibits to-day, I have found much of surprising interest and we are all profoundly thankful to you for the invitation to come and see the Exhibition before the visitors which I have no doubt will throng it from day to day onwards. (Applause.)

Mr. Algernon E. Aspinall, Secretary of the West India Committee: Having come here with a rather elaborate speech prepared eulogising the chairman who I expected to see occupying the chair—Sir Henry A. Blake—I was rather disconcerted to find a substitute in his place. But Major Sanderson is so well known to all of you, and he has conducted the proceedings with much marked ability, as he has, indeed, the great amount of work he has done in connection with the rubber industry, that I feel no words of mine are needed to commend to you the toast of his health; and as you are all anxious to see the magnificent feast of rubber prepared for you downstairs, I shall not keep you longer, but will at once propose, with all heartiness, the toast of our esteemed chairman, Major Sanderson.

The toast having been drunk with much enthusiasm,

The Chairman said: Ladies and gentlemen, I thank you very much indeed for the kind way in which you have received this toast. I feel that I have only done that which any deputy should do, namely, stepped into the breach as necessity arose. It has given me great

pleasure to preside at this lunch, and I trust we may all meet together later in the Exhibition. (Applause.)

Mr. EDWARD SALMON, of the *Rubber World*: Mr. Chairman, ladies and gentlemen, I am sure you will not wish to go from this hospitable board without paying your tribute to the names of Mr. Manders and Miss Fulton. (Hear, hear.) My colleague and friend of the *Daily Telegraph* mentioned a few moments ago that he had seen the Exhibition in the making. I think I may claim to have seen the Exhibition long before it was in the making, and if you only knew the hard work, the extraordinary ingenuity, the enterprise, and the extreme good fellowship —if I may say so—which has been brought to bear upon the production of what will be a record Exhibition in the history of the rubber world, you would agree that the two people—apart from our President, who is, of course, an excellent figure-head—who are most to be praised are Mr. Manders and Miss Fulton. If I might for one moment, in the presence of some of my German colleagues, say this, I would like to suggest to you that this Exhibition is a proof that all the organising ability of the world is not confined within the borders of Germany. I think that when we walk through this Exhibition we shall realise that there are brains in this country capable of commanding forces from all parts of the world, and putting them into the Agricultural Hall in a way that will show what a great and interesting industry it is. Here you will be able to see not only rubber in the making, but rubber in the growing, and I hope you will be able to see it growing to your profit. Let us not forget that we owe all this to Mr. Manders' brain, but Mr. Manders would not have been able to accomplish so much but for the co-operation and loyal assistance of his niece, Miss Fulton. (Applause.) I give you "Health and Long Life to Mr. Manders and Miss Fulton."

The toast was drunk with musical honours.

Mr. MANDERS, in responding, said: Mr. Chairman, and ladies and gentlemen, on behalf of my niece and myself I thank you most sincerely for the kind way in which the toast has been proposed, and the way in which you have received it. Certainly we have worked very hard in connection with this Exhibition, but we have received a wonderful amount of assistance and support, not only from England, but from all parts of the world. I myself have visited many countries. Mr. Salmon mentioned Germany, and I may say that during my visit to Germany I had the kind support of everyone interested in the rubber industry in that country. I have also had the assistance of the German Consul in London, and the result is a fine section representing that country. Then take the Dutch section, we have had the benefit of the kind support of the Consul in London and the Committee in that country. I would say the same of Belgium. We have had every assistance there also. They promised us a fine show, and if you visit it, I am sure you will find it is of the finest. So you may go all around the Exhibition. Some of the exhibits may be small, but they are all interesting. I will not detain you longer, but will only again, on behalf of my niece and myself, thank you for the way you have drunk our health.

The proceedings then terminated.

During the evening the following telegram was received from His Majesty:—

"Royal Yacht, Portsmouth.

"Sir Henry A. Blake.

"I am commanded by the King to thank you and those who joined with you for your kind message and good wishes.—BIGGE."

Opening Ceremony.

Monday, 26th June.

The official opening of the International Rubber and Allied Trades Exhibition took place on Monday, June 26th, at 3 p.m., in the centre Hall. The President, Sir Henry A. Blake, G.C.M.G., with members of the Reception Committee, met the Right Hon. the Earl of Selborne, K.G., at the main entrance, and accompanied him to the dais. Amongst the very large attendance, the following were present : The Right Hon. Lord Elphinstone, His Excellency F. Regis de Oliveira (Brazilian Minister), His Excellency Lew Yuk-Lin (Chinese Minister), Sir Henry and Lady Blake, Sir Harry H. Johnstone, G.C.M.G., Sir Frank Swettenham, K.C.M.G., Sir William Taylor, K.C.M.G., Sir William and Lady Treacher, Col. Sir T. Hungerford Holdich, K.C.M.G., Sir William Wallace, K.C.M.G., Sir Daniel Morris, K.C.M.G., Sir F. Fleming, K.C.M.G., Sir Ernest and Lady Birch, the Hon. Sir C. P. Layard, Sir John Furley, Col. and Lady Florence Beresford Ashe, Sir S. C. and Lady Obeysekere, Sir George and Lady Murray, Sir W. E. Ward, K.C.S.I., Sir Everard im Thurn, K.C.M.G., Sir John and Lady Muir McKenzie, Sir Walter and Lady Egerton, Sir Frederick Graham, K.C.B., Duc d'Ursel (Belgium), Baron de Haulleville (Belgium), Col. W. J. Warden, Lt.-Col. E. C. Davies, Baron von Ungetter, Dr. Sim Boon Keng, Lt.-Col. Arthur Chapman, the Hon. R. P. Robbins, Major Frazer, C.L.I., Capt. and Mrs. Mueller, the Hon. S. W. Knaggs, C.M.G., the Hon. J. Pringh, C.M.G., the Hon. C. H. Strutt, the Most Rev. Enos Kutall, D.O., Raja Chulan (F.M.S.), Raja Harun (F.M.S.), Raja Rashid (F.M.S.), Mr. P. D. Warren, C.M.G., Mr. W. E. Davidson, C.M.G., Mr. H. S. J. Maas (Consul General for the Netherlands), Dr. H. Johannes (Consul General for Germany), Mr. E. Pollet, (Consul General for Belgium), Mrs. and Miss Pollet, Mr. F. Alves Vieira (Consul General of Brazil), Col. Pedro Saurez (Consul General for Bolivia), Mr. Adolpho Bullé (Consul General for Mexico), Mr. H. Kerr Rutherford, Mr. Jno. C. Sanderson, Mr. and Mrs. E. Rosling, (Ceylon), Mr. Norman Grieve, Mr. and Mrs. A. Bethune, Mr. Herbert Wright Dr. W. R. Tromp de Haas (Netherland East Indies), A. G. N. Swart, LL.D. (The Hague) and Mrs Swart, Dr. Bisschop, Mr. and Mrs. J. C. von Hemert (Amsterdam), Mr. G. A. Talbot, Mr. Roger Ehrhardt (Belgium), Mr. Leon Osterrieth (Belgium), Mr. M. van Biervliet, Mr. Paul Osterrieth (Belgium), Mr. W. Martin Leake, Mr. J. McEwan, Mr. J. L. Loudoun-Shand, Mr. C. Taylor, Dr. and Mrs. Joseph Torrey, Mr. J. A. Richardson (Southern India), Mr. André Cremazy (Indo-Chine), Mr. A. D. Cillard (Paris), Dr. Werner Esch (Hamburg), Mr. Leonard Wray, I.S.O., Mr. A. E. Aspinall, Dr. and Mrs. Jacques Huber (Para), Senor Emilio Castre (Peru), Mr. W. H. Hildreth, Mr. Georges Francois (Occidental Africa), Mr. Francis Crowther (Gold Coast), Mr. W. S. D. Tudhope (Gold Coast), Prof. Carmody, F.I.C. (Trinidad), Mr. A. F. Stockdale (British Guiana), Mr. R. Fyffe (Uganda), Mr. H. Powell (East Africa Protectorate), Mr. Paulo Gerechter (Manaos), Mr. and Mrs. Charles Grenier (F.M.S.), Mr. E. E. Buckleton, Mr. F. J. B. Dykes, Mr. G. van den Kerckhove (Belgium), Mr. Thorold Waters, Mrs. A. Staines Manders and Mrs. Kirkby, Dr. W. Walton Claridge, Mr. Jayme de Argollo Ferrao Jor (Brazil), Dr. A. J. Chalmers, Dr. L. Munziger,

Dr. J. R. Phillips, Dr. Sandmann (Berlin), Dr. and Mrs. Fritz Frank (Berlin), Mr. H. de Vasconcellos, Mr. H. S. Smith (Tobago), Mr. and Mrs. George Springer (Berlin), Dr. and Mrs. P. Schidrowitz, Dr. Griffen, Mr. Frank W. Gibson, Mr. and Mrs. Bamber (Ceylon), Mr. and Mrs. F. Crosbie Roles (Ceylon), Mr. and Mrs. A. S. Angier, Mr. G. H. Golledge (Ceylon), Mr. Richard Hoffmann, Mr. A. L. Bains, Mr. Noel G. Bingley, Mr. and Mrs. A. L. Hutchinson, Miss B. E. Merfield (Australia), Dr. Robert de Decker, Mr. H. Hamel Smith, Mr. and Mrs. Gerald Fitz-Gibbon, Mr. B. L. S. Winton, Dr. H. and Miss Lewkowich, Ronald Ferguson, Esq. (Ceylon), Mr. and Mrs. H. Storey (Ceylon), Mr. W. Botting Helmsley, F.R.S., Mr. G. S. Brown, Mr. Hy. Bois, Mr. F. J. Branthwaite, Mr. and Mrs. R. W. Harrison, Mrs. Temple, Mr. W. T. Gibson, Mr. T. Wickham-Jones, Mr. and Mrs. Noel Trotter, Mr. W. Fawcett, B.Sc., Mr. M. A. Ritter, Mr. G. B. Leechman (Ceylon), Mr. M. J. Mitchell, Mr. Norman Grey, Mr. J. M. Vanhouse, Mr. F. Mukleberg, Dr. Hans Plehn, Dr. Hennings, Mr. J. H. W. Park, Mr. and Mrs. Tan Jiak Kim (F.M.S.), Herr Memmler (Berlin), Mr. W. Schultz, Mr. K. H. H. van Bennekom (The Hague), Herr Runge, Mr. Mark Hydes, Herr von Neuforge, Dr. Henry Stevens, Mr. Morland M. Dessau, Mr. A. Oliphant Devitt, Mr. Howard B. Figgis, Mr. F. L. Rawson, Mr. Patrick Gow, Mr. R. Rutherford, Mr. C. A. Sack, Mr. H. A. Wickham, Mr. F. Copeman, Mr. C. J. Scott, Mr. and Mrs. Hagen, Mr. C. Windschuegl, Mr. and Mrs. Krieger, Mr. and Mrs. Korten, Mr. and Mrs. Rees, Mr. Paul Brodtmann, Mr. and Mrs. Roese, Mr. Koenigs, Mr. Cyril Baxendale (F.M.S.), Mr. Arthur Dew, Mr. J. A. Musly (Rotterdam), Mr. Ch. H. Moens, Mr. B. Bakker, Mr. J. Merens, Mr. A. Slingervoet Ramondt (Delft), Mr. Malcolm Cummings, Mr. F. H. Layard (Ceylon), Mr. Edward Salmon, Mr. Edward Pfaff (New York), Mr. D. S. Hunter, Mr. Theo. E. Smith (Ohio), Mr. W. B. Slater, Mr. A. C. Wylie, Mr. James Ryan (Ceylon), Mr. F. J. Ingleby (Ceylon), Mr. A. Staines Manders (Organising Manager), Miss D. Fulton (Secretary).

NOTE.—The above are only a few of those who were present, as, with such a large audience, it was not possible to ascertain the whole of the names, consequently those of many gentlemen well known in the rubber world, will necessarily be missing.

Sir HENRY BLAKE: This exhibition was decided upon three years ago, in the year 1908, when an exhibition was held at Olympia. That exhibition of rubber in all its forms had not only exhibitors from a great many countries, but during its continuance papers were read by scientific experts from Europe, Asia, Africa, and America. Those papers were of the utmost value to all interested in the growing, production and preparation for the market of rubber and its allied productions; and now we have here exhibitors, delegates and officials representative of every rubber-growing country in the world. They have met together in friendly international co-operation for the purpose of marking the progress that has been made in this great and growing industry since the last exhibition, and also for the discussion of papers that will be read with reference to future problems that have been evolved. Everybody who has seen the exhibition up to the present—and I especially, who know what has been done—is satisfied, and I think your lordship will be satisfied that a great advance has been made in the industry, the extent and value of which are very little appreciated by the public at large. I believe that the production of rubber last year was about 75,000 tons, which at the average price of last year—which was about 7/- per lb.—represented I think, a sum of about 85 millions sterling. But a very small fringe of this industry has been touched. All

the rubber being shipped, the wild rubber from Brazil, all the plantation rubber that has yet come to the market, is but a very small amount in comparison with the amount of rubber that will be put upon the market within the next two or three years. Some people have assumed that the price of rubber must go down considerably in consequence of the increased production. As a man who has some interest in rubber planting, I earnestly hope that it will, for it is a mistake to imagine that the price of rubber must necessarily, if it goes down, interfere with the return on the capital. The amount that up to the present is being won from the matured trees will be enormously increased in the near future, and the increased yield of the matured trees will more than compensate for a decrease in price that will bring the rubber industry into an entirely different horizon. Manufacturers who are here represented are only waiting for rubber at a reasonable price to enable them to look forward to a limitless expansion of the horizon of the rubber uses. There are scores of directions in which manufacturers are only waiting for that time to come in order to enlarge their manufactories at once, and when that time comes rubber will be as staple a produce all over the world as wheat. I remember at the opening of the last exhibition in Olympia I ventured to say that the time was approaching when, possibly, rubber would compete with other substances for the paving of our streets. Well, your lordship, I think that as you entered this building to-day you passed over two specimens of rubber which have been laid down by the enterprise of the North British Rubber Co., and there you see that the problem of street paving has made great strides. I do not say that the time has yet arrived, but I have no doubt whatever that the time will soon arrive when the process will be absolutely completed and render everything that is requisite for the purpose of street paving. And when that time comes I need hardly tell you that the diminution of nerve strain and brain fag by the cessation of the street noises as at present will bring improved health and comfort to the busy workers of our great city. (Applause.) There will also be seen in the exhibition the chemical processes used in the preparation of rubber and also the mechanical operations in the preparations of it for manufacture. I will not detain your lordship longer, but I will ask you on behalf of the Committee to do them the honour to declare the exhibition open. (Applause.)

Lord Selborne: This exhibition is an exhibition at which all the countries of the world are represented, that is, all the countries in which rubber is produced. This will show you how remarkable is the character of this exhibition, both in the completeness of the exhibits and also in the authority under which the exhibits are presented for the inspection of the public of the world. I will make only three observations in respect to this rubber industry. The first is what a great contribution it has been—and will be probably much more so in the future—to the solution of the prosperity of some of those parts of the British Empire whose administrative lot has been one of struggling in its financial character for a good many years past. (Hear, hear.) Think of the effects of the development of the rubber industry on the West Indies, and on different parts of Africa, not to mention the East, and you will see at once how in the production of rubber may lie the secret of prosperity and financial stability hitherto unknown in these tropical and semi-tropical parts of the British Empire. The second observation I would make is this, that apparently this is the first time in which the tree products of the tropical zone are likely to rival in their adaptation for the purposes of art and manufacture the tree products of the temperate zone. And thirdly, is

it not curious how long it has taken since the properties of rubber were first known, to begin to realise the purposes for which rubber might be used. After all, rubber is not an invention of yesterday or of ten years ago, but it is only quite recently that the world has become to realise the place that rubber is going to take in the arts and manufactures of the world. (Hear, hear.) I think this ought to be an encouragement to all inventors. They need not despair with Alexander that there are no more worlds to conquer. On the contrary, rubber shows them once more there are many more opportunities in store for them in the future than they have conquered in the past. I have much pleasure in announcing this exhibition to be opened. (Applause.)

His Lordship, with Sir Henry A. Blake, Members of the Reception Committee, A. Staines Manders (Organising Manager) and Miss D. Fulton (Secretary) then made a tour of the exhibits.

Tuesday, June 27th.

Prince Henry of the Netherlands, who was accompanied by the Dutch Ambassador, visited the International Rubber Exhibition at the Agricultural Hall, and was met at the entrance by Sir Henry Blake, the president, of the Exhibition, Mr. N. S. J. Maas, hon. president, Mr. A. G. M. Swart, president, and members of the Royal Commission for the Netherlands, and Mr. Staines Manders. Miss Swart, a daughter of the president of the Netherlands Commission, presented his Royal Highness with a bouquet. He was then conducted through the Exhibition, and expressed his pleasure at the arrangements.

Prince de Ligne, representing the King of the Belgians, also visited the Exhibition, and was met by Mr. E. Pollet (Consul-General for Belgium), MM. R. Ehrhardt and Leon Osterrieth, and Mr. A. Staines Manders. The Prince evinced the keenest interest in the exhibits.

Mr. E. Rosling (Commissioner for Ceylon), and Mrs. Rosling held a private reception, to which a large number of guests were invited.

Wednesday, June 28th.

His Excellency the Portuguese Minister visited the International Rubber Exhibition, and was conducted through the hall by Mr. Staines Manders and Major Martin Hertz.

BELGIAN DAY.

Reception given by the Committee of the Belgian Section of the International Rubber Exhibition.

The Reforms in the Belgian Congo.

By M. WENDELEN.

FRIDAY, JUNE 30TH.

On Friday, June 30th, the Belgian Section held a reception, which was very largely attended. The chief feature was a lecture by Monsieur Wendelen, Advocate in Brussels, on Reforms in the Congo. M. Edward Bunge, one of the Presidents of the Belgian Committee, took the chair, and was assisted by Mr. E. Pollet, Consul-General for Belgium, also President of the Committee, Sir Henry A. Blake, G.C.M.G., ex-governor of Ceylon, Hong Kong, Jamaica and Bahama, the Duc d'Ursel, Sir A. K. Rollit, Grand-Cross of the Order of Leopold, MM. Ehrhardt and Osterrieth, Secretaries, Baron de Hauleville, Delegate of the Belgian Colonial Office Branch, M. Albrecht, Alderman of Antwerp, M. van de Velde, Delegate of the Antwerp Chamber of Commerce, also Messrs. John McEwan, Herbert Wright, A. Staines Manders, Manager of the International Rubber Exhibition.

Sir HENRY A. BLAKE, President of the International Rubber Exhibition, in opening the proceedings, said :—Mr. Chairman, ladies and gentlemen, on behalf of the Committee I wish first of all to say a few words in hearty welcome of Mr. Bunge and the gentlemen connected with the Belgian Court, which, by its artistic arrangement, has added so much in securing an attractive presentation of the various sources of rubber, which is the meaning mainly of this exhibition. We shall listen with very great interest to the paper that is to be read by M. Wendelen on the Reform of the Congo. We know that in the past there have been statements about the Congo State that probably in some cases were true, and probably in some others may have been greatly exaggerated, but one thing we know—and I am sure we shall hear with great gratification—that under the reforms that have been undertaken by the beneficent young King of the Belgians we may be assured that the blessings of true civilisation, in the shape of justice and security, and individual liberty, will open the door to the future happiness of the millions of people of that great and fertile region of the Congo, and I have no doubt that with these blessings the products of the Congo will in the near future have a ready market on both sides of the Atlantic. We are all here interested in the same thing: we want to see the progress, the progress which means the co-operative benefit of the producer and the consumer, and I hope that amongst the regions that will supply the great product in the interests of which this exhibition is being held, the Congo will be a very great factor. As I have said, I have only on the part of the Committee to welcome most warmly and heartily the Belgian gentlemen who have done us the honour to join in this exhibition, and to express the hope that the result of this exhibition will be, for them and for everyone connected with it, wholly beneficial in the future. (Applause.)

Mr. BUNGE, in reply, said: Ladies and gentlemen, I am very much obliged to our esteemed and distinguished Chairman, Sir Henry Blake, for the very kind words he has just now said. In saying so, I feel myself at one with all my compatriots here present, and, indeed, with many more at home who take an interest in this interesting exhibition, that this rubber exhibition gives us Belgians a welcome opportunity of showing our English hosts that we want to be, and are proud of being, their disciples. We have been so, in fact, from the very beginning of our national existence, and we gratefully recognise that by following in England's footsteps, in the paths of humanity, commerce and industry, we have fared well morally and materially. When we went to the East to join hands with our English friends in the early times of that great industry of rubber growing, we were frankly and unreservedly welcomed by them. There never was even the shadow of that narrowmindedness which looks askance at the stranger. It was the door flung wide open to all comers provided they were willing to co-operate in the development of the land and to honestly abide by its laws. For this, ladies and gentlemen, we are grateful, and we mean to show it by dealing in the same spirit with all who may choose our own colony, the Congo, as a fit field for their energies, and for their spirit of enterprise. However the past may be judged, whatever that past may have been, that is the spirit in which our Government and people approach the problem of opening up their vast territories both for the benefit of those who were there from olden times and those who now go there, whatever their nationality may be. Having touched upon this subject, I now beg to introduce to you M. Wendelen, who is in a position to speak with more authority than I could. I am sure you will like to hear him.

Monsieur WENDELEN, Advocate in Brussels, then delivered the following address on the Reforms in the Belgian Congo. He said:—

The Rubber Exhibition affords an opportunity for viewing with wonder and admiration the marvellous development of a new source of wealth, *i.e.*, the production of plantation rubber, and London is indeed the place for such an exhibition, because the world, once more, owes this revelation to English initiative and tenacity.

Belgium was one of the first to take a share in these efforts, thanks especially to the enterprising spirit of the Antwerp merchants, and lately (not quite three years since), she has become the mistress of the destinies of Belgian Congo.

This Colony, which at present produces annually several thousands of tons of wild rubber and which is the future field for important plantations confers upon its metropolis the right—nay, makes it her duty—to participate in the London Exhibition.

As regards her Colony, Belgium has nothing technical to teach the mighty producing nations that surround her, the foremost of which receives her here. But she can call them in as witnesses, not without pride, to the energetic and conscientious efforts she there is making for the sake of humanity.

This indispensable material, rubber, has up till now been looted, as it were, from the wildest forests of Africa and America—always in insufficient quantity.

Its cultivation having begun in Asia a few years since, we now see rubber produced in quantities whose stupendous increase, scientifically assured, may be calculated and forseen with admirable certainty. And this cultivation not only brings well deserved wealth to its English promoters and its European managers, but means welfare, comfort and progress to the original owners of the soil—the natives who supply the

indispensable labour—and Belgium's object in Congo is to follow these ideals in gathering the wild rubber—that is, to give the natives who do the work, a share in the profit realised, to assure for them, through the kindness of the public authorities, and through the effects of free competition as established on their soil, increased comfort and progress.

We now intend to set forth in a few words, the means used in furtherance of this end, and the results that can already be seen.

Twenty years ago the native population of Central Africa was outrageously decimated by Arab slavery, while the Coast tribes were poisoned by the alcohol of the white traders. The late Congo Free State has valiantly—regardless of cost—delivered them from these two plagues under which they were perishing. But compelled, as it was, to accomplish with insignificant resources a giant's task, forced to occupy at once in all its vastness an immense territory—any part of which, left unguarded, would have become the scene of international strife—the State was forced by fate to put budget considerations foremost. But, not being backened by a metropolis, it was soon compelled, in order to obtain the necessary means, to have recourse for the natural exploitation of its territory, to collect rubber directly or through commercial companies. But, when the Congo became a Belgian colony, its metropolis being a rich country able to face the cost of organizing her new possession and determined not to stint her resources there, Belgium set out to modify a form of government which only the dire necessity of existence had established and maintained; Belgium, moreover, being essentially an industrial and exporting country, has, unlike the European countries, stood with England in its attachment to the idea of liberty in the economic realm, as in all others. Such have her ancient heritage and her geographical position made her, and such she remains from choice and of necessity.

This mentality so deeply stamped on the race, manifests itself strongly in the Legislative Assemblies called together by an almost universal suffrage. And these Assemblies wield, through the law of October 18th, 1908, an absolute control over the administration of the Colony.

Belgium, like England, is fortunate in having a young king who is popular with all classes of the nation. Ever since his youth he has busied himself with social questions for the betterment of mankind. He went personally to visit the Colony, which he traversed from end to end. The photographs which you will find in the Belgian exhibits were taken by him and his companions. We see him appear there not only in regal array, but also in the garb of the explorer—of the strong pioneer, who travels on foot through the jungle. He has seen the country and knows the misery and the needs of its inhabitants.

A young Queen, admirable alike as a wife and as a mother, born of a family in which charity and active kindness are hereditary virtues, lives at his side. She was recently greeted, on her first appearance after her recovery from last winter's severe illness, by an outburst of popular adoration. Every Belgian this season wears her colours—the Queen's flower—which is sold to help a charitable institution of her choice. This year the flower is the *edelweiss*, and the charitable purpose is to fight the plague of sleeping sickness in the Congo. By buying one of these you, visitors to the Exhibition, will help to save lives in Central Africa; you help fight the battle which is being fought in Belgian Congo by 74 doctors and numerous assistants as well as by sisters and missionaries who have received a special training and who control a staff of over 2,000 natives.

M. Jules Renkin, Minister for the Colonies, who has held position since the Colony was taken over, belongs to the most democratic element

of the party in power. He is an untiring worker, and his robust health allows him to accomplish unfalteringly an enormous task. In his first year of office, he, too, visited the Colony, heard the missionaries, questioned the natives, and studied minutely the country he was going to reorganise.

M. Tibbaut, a member of the party in power, and reporter of the Colonial laws and budgets, since the taking over, has also made a journey of investigation in the Congo; and the observations and criticisms expressed, with regard only to the truth, in his well-studied reports, are permeated with a knowledge acquired on the spot.

Finally, even the leader of the Socialist Opposition, M. Vandervelde, is on his third journey to the Colony.

Under those concordant impulses—arising from and backed by almost unanimous public opinion—Belgium, since the annexation, has adopted a policy of outright reform. She has done so without regard to the burdens therewith connected which she stands ready to bear.

The transformation was a rapid one.

The taking over of the Colony was voted on the 15th November, 1908. The future King, the Minister for the Colony, and several others prominent, visited Congo in 1909. Numerous reforms in matters of detail were accomplished, and a comprehensive plan was worked out.

The ordinances in which the keynote was struck appeared at the beginning of 1910—on the 23rd of February, 17th, 19th and 22nd of March, and on the 2nd of May.

The basis of the method of government is from now on "Free Trade backed by Free Labour," and thus it was proclaimed by M. Tibbaut in his report on the first Colonial Budget.

The working of the estates of the realm by monopoly is totally abandoned. The native may now gather rubber freely. He has not the slightest formality to fulfil, nor the slightest tax to pay. He only has to observe the regulations issued with the object of preventing the destruction of the latex yielding plants. He can sell the product of his labour to whom he likes, and at the market price. On the other hand the buyer—the European or foreign trader—can settle on any tract not already leased or granted. He can buy from the native the rubber he has collected; he can also collect rubber himself or have it collected for him. He can buy crown lands to settle on, and if the amount of land he desires does not exceed 10 hectares (25 acres) in area, he can obtain it on the spot, by putting in his demand together with a rough sketch outlining the tract. The Governor General, in strong circular letters, urges the local boards to favour such applications for land, to hasten their inspection, to simplify the formalities, to receive, inform, and encourage the trader or the cultivator who wishes to settle.

If he does not wish to acquire the piece of land immediately—if he wishes to investigate the resources of the district and his chances of success before settling—he can take the land on a 15 years' lease, with the sole proviso that he occupies it himself, or by his proxy, and that he carries on effectively his trade or industry.

The price of land is generally 1 franc (10d.) per square meter (sq. yard) within the town limits; outside, the price is 1,000 frs. (£40) per hectare (2½ acres) for land intended for trading posts, and from 10 to 25 frs. (8s. to £1) per hectare (2½ acres), according to location for agricultural lands. The rent is 5 per cent. of the value of the ground.

The native, although free to harvest, is no longer obliged to do so. The tax paid in produce is abolished, as well as that paid in food. The Government buys for cash all the produce required. The agents are no

longer revictualled ; they receive a food indemnity, and they must pay in cash for the foodstuffs which the natives bring them freely. There is, therefore, no more forced collection of rubber, nor forced supply of food ; and there is no more enforced toil for even the most urgent public works. Since the annexation, all the labourers in the railway yards have been freed and are now engaged of their own free will for a three years' term. They receive their pay in cash.

The tax is now paid in cash. The local government boards are strictly forbidden to accept payment of the tax in rubber, even when it is offered by the native. As for the districts where money has not yet been introduced, the collection of the tax is suspended ; but money is spreading more rapidly and easily than one would have thought. The Government since the annexation, has introduced, over 10 million francs (£400,000) in money. Private individuals, certain companies, and the banks which have been established, have also introduced large amounts, and the natives have soon learned to use it.

The new tax, therefore, is easily paid. The old direct and personal taxes have been replaced by one principal tax, which is from ⅓ to ½ what it formerly was, varying from 5 to 12 frs. (4s. to 9s. 7d.) according to the districts, and which is only imposed on full grown and able male natives. A light supplementary tax is laid on more than ordinary wealth, as indicated by the possession of several wives, which, in Africa, is the surest sign of prosperity.

The Colonial charter authorises appropriate reduction of and exemption from taxes, and both are practised to a large extent.

What, now, are the taxes and fiscal obligations to which a European or other foreign trader in rubber is subjected ?

Under the old *régime* he had to pay a licence of 5,000 francs (£200), and he was also under the costly obligation to replant rubber bearing species. To-day he only has to take out a collecting permit, which costs him 250 francs (£10) and is available for a year. He pays an export duty of 60 centimes (6d.) per kilo. (2 lbs.), and a replantation duty and tax which are respectively 75 centimes (7½d.) and 40 centimes (4d.) per kilo. of rubber gathered from trees or vines, and 50 centimes (5d.) and 20 centimes (2d.) per kilo. of " grass rubber." These are the only charges pertaining to this special trade.

As to the general taxes, they are certainly not excessive. The travelling merchant pays a licence of 500 frs. (£20). The merchant, or the farmer who has a settled establishment in the colony, pays on his buildings a tax of 75 centimes (7½d.) per square metre (yard), which is reduced to 25 centimes (2½d.) for such buildings as are used to house the native staff. He pays 10 frs. (8s.) per servant, 5 frs. (4s.) per workman, and from 2 to 10 frs. (1s. 8d. to 8s.) per ton for the ships he uses, according to the class they belong to.

Let us mention here that the farmer who wishes to establish rubber plantations in the Congo receives certain favours which do not affect one who only collects wild rubber. These are : reduction of the tax on each native labourer employed to 1 franc (10d.) instead of 5 frs. (4s.) ; remission of the tax of 75 centimes (7½d.) per kilo. (2 lbs.) of harvested rubber, and remission of all tax on the buildings for farming or cattle growing.

The Colony also busies herself with the establishment of large plantations, a special fund maintained by the replantation tax previously mentioned being devoted to this purpose.

So much for the system of government, the equity and moderation of which are acknowledged by its subjects, under which reforms are

willingly approved by the Government, voted with enthusiasm by the Assemblies, and applied in good faith.

The instructions given by the Government to its agents are expressed and reiterated in peremptory terms. Their execution is closely watched. Reprimands have been administered to certain agents who had accepted payment of taxes in rubber, the natives having offered them in that form.

Numerous Europeans of various nationalities have already taken advantage of the new *régime* to settle in various points of the country. Nearly 200 sales or leases of Crown lands have already been granted. Moreover, five important concessions were granted, as per agreement of April 14th, 1911, to Messrs. Lever Brothers, Ltd., of Port Sunlight, for the working principally of oil factories. Messrs. Lever Brothers are well known for their extensive business and the philanthropic and social manner in which they carry on their work wherever they settle themselves. They are obliged by the Government to establish in each concession a school and a lazaret.

On the other hand, the religious missions are spreading and rapidly accomplishing their occupation of the land. They have every support from the Belgian Government, which has been Catholic for the last 27 years.

Two interesting maps posted in the Belgian section show the distribution and organisation of the Catholic and Protestant missions, whose ramifications spread over the whole territory. The Protestant missions possess 46 establishments in the Congo, and since the reforms, eight sales or leases of Crown lands have been negotiated with them. Catholic or Protestant, they all work with zeal to educate the native children ; they are mighty assistants to the State in their unsparing efforts to fight the plague of sleeping sickness.

All are requested to send delegates to the Leopoldville's bactereological laboratory. Travelling and all other expenses are paid by the Government to missionaries who devote their energy to the study and the treatment of trypanosis in said laboratory. Amongst the 29 lazarets established by the Government, some are managed by missionaries and are entrusted to graduated religious nurses especially trained for that purpose.

Missionaries, planters, and merchants, freely distributed all over the territory, mould public opinion, and under this efficacious control is the methodical application of the reforms brought about.

This is not the work of a day, and no Government with commonsense would think of upsetting the whole interior economy of an immense territory by transforming its whole administration with a touch of the magic wand. Precautions had to be taken ; gradual transitions had to be arranged, and experiments had to be made. A whole staff permeated with other ideas, and accustomed to other ways, had to be rallied, instructed and directed, and that at enormous distances. It was therefore decided to proceed gradually in the work of reorganisation. The Ordinance of March 22nd, 1910, divided the colony in three zones, whose transition to the new methods had to be brought about from year to year. The first zone (tinted bistre on the map) was opened to free trade on July 1st, 1910. This zone alone comprises three-fifths of the territory. Its area is three times that of the United Kingdom. It spreads over the whole southern half of the Colony, and almost compasses the whole. The reforms have thus been applied to all the districts in contact with neighbouring colonies, as soon as they were enacted.

The second zone (tinted a striped green on the map) will be opened to-morrow, July 1st. It comprises the whole centre of the Colony—its richest districts in rubber—the domain of the old Crown Estate.

Finally, the third zone (tinted pink), which comprises the north of the territory with a part of the centre will see the reforms completely applied from July 1st, 1912.

The Government, moreover, is anxious to have the task accomplished and whenever it can be done without grave inconvenience, she anticipates the set dates. Sales of land are now being conducted in the three zones, and have been for several months past on the basis established by the new Government. Companies and private individuals are settling. The tax in foodstuffs is also from now on, abolished in the three zones.

But the three tints which colour the map do not comprise its entire area. Large white spaces remain, and it is also dotted with five dark green patches. The latter indicate the forest reservations where all harvesting is prohibited for the time being for the sake of preserving the native plants.

The white spaces show the grants of territory to land-owning companies under the old Government. The Belgian State could not abolish these Concessions, but has not given up the idea of bringing about their relinquishment. Negotiations are being carried on with the title holders of monopolies or property, the Government being anxious to secure uniformity throughout the whole system. The results—obtained sometimes at a great sacrifice—are already considerable.

One of those thus re-purchased does not even show on the map. It involves the immense territories of the South-West, where the Kassai Company had an actual monopoly; in whose profits the State had a half share. This monopoly is abolished. Belgium has given up her share in partial compensation and her shares in the profits have been done away with. The old territories which the Kassai Company used to work, but where competitors are settling now, are merged in the first zone, which is coloured bistre on the map.

But three great vacant spaces still remain on the map: to the east of Lualaba, to the north and to the south of the great Congo river bend. The first one is shrinking and rapidly diminishing. It indicates the territories which were set aside for the Great Lakes Railway Company, at the rate of four million hectares (ten million acres) for every 25 million of francs (one million pounds) of capital spent.

Two lines already laid have cost 50 million francs (two million pounds) and caused a grant of eight million hectares (20 million acres) of forests worked by the Government on half shares with the company.

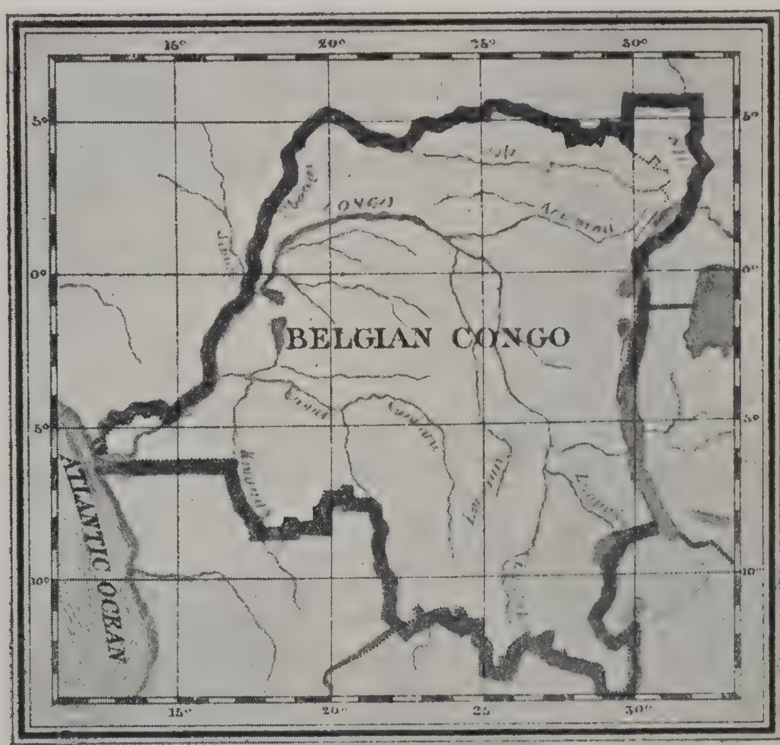
The undertaking of a new line towards Lake Tanganika will cost another 25 million francs (one million pounds), but the concession of land will not be extensive this time. The company agrees to limit itself to the forests already granted, only increasing the proportion of its share in the profits of their working. The immense areas left for future concessions are thus immediately thrown open again to the initiative of free trade. (Agreement dated 11th February, 1911, approved of by the Legislative Assembly on May 12th).

The other two important blank spaces still on the map are disappearing in turn also, and totally.

These represent the concessions granted to two old companies of land-owners: the Abir (Anglo-Belgian India Rubber Co.) and the Société Anversoise du Commerce au Congo (Antwerp-Congo Trading Co.). By agreement, dated May 23rd, 1911, these two companies abandon their

monopoly, relinquish their right of ownership, and keep only their stations and plots of land for plantations, agreeing to bring them into working order. Belgium gives up her share in the profits. Eighteen months after the approval of the agreement by the Legislative Assemblies, the territories, worked up till now by the two companies, will in turn be thrown open to free harvesting.

The extension of the reforms to the whole territory is thus a certainty. It now nears completion, and will be accomplished in a year's time. We may from now on declare nine-tenths of the enormous territories of Central Africa open to free harvesting, open to free trade, and open to free labour.



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At the close of the address, which was listened to with great interest by the very large number of ladies and gentlemen present and was frequently applauded,

The CHAIRMAN said: I will now ask Sir Albert K. Rollit, whom we know so well in Belgium, and who has been a staunch friend to the Belgian people for many years, to say a few words.

Sir ALBERT K. ROLLIT: Mr. Chairman, ladies and gentlemen, whether from my long experience with Chambers of Commerce in this country, or because I happened to represent this division of the Metropolis in Parliament for twenty years, or, as I would prefer, from the existence of those friendly and kindly feelings which have been expressed towards me by the chairman, I have great pleasure in moving a resolution which I know beforehand will be very acceptable to yourselves, and that is a vote of thanks to Mr. Wendelen for the admirable address which has been given us to-day. (Applause.) Full of instruction, replete with history and facts, which are not always synonymous, and at the same time expressed in those moderate terms, which are best calculated to carry conviction, what we have heard has interested, instructed and delighted us, and we are quite ready, I am sure, to pay those thanks which are so eminently due. One speaker said that rubber was now indispensable. In my early youth I remember that its chief use was as an ink eraser, and those of us who have studied horticulture know something

of *ficus elastica*, as an India-rubber plant which I think has been replaced by a number of varieties of a better character. Well, now, India-rubber is not only indispensable, but it is the chief factor in probably the greatest characteristic of modern times, and that is of this age of mobility on land, at sea, and in the air. We live in a centre of perpetual motion. An answer is given to a question in scripture, " Can a leopard change its spots ? " So great is the mobility of the day, that the answer is " Of course he can ; thanks to the mobility of the day he can move from one spot to another." (Laughter.) I should like next to say, that it is both the duty and the interest of our people to notice, and be instructed by, the Belgian section, particularly in this exhibition. The trade between the two countries is a matter of great importance. It is an equal trade. It is a trade which is not fettered by hostile—much less exclusive—traffic. Some of us remember the perhaps even better times still when, like our own country, Belgium was an absolutely Free Trade country ; but at any rate we respect Belgium as having only a moderate tariff. We are good customers of each other ; and we English do a great deal of the shipping of Belgium, and these freights are a material source of income. For these reasons we are under an obligation to the Belgian people, and I trust the feeling will always be cultivated, not only as regards political considerations, not only in the relationships of the Royal families which are close, and friendly, but also as regards those economical and trade relations which are beneficial to both countries, consisting as they do in an interchange of necessary commodities. Then I would like to say that Belgian exhibitions are always useful and instructive, and in saying that I speak with an experience of twenty or thirty years, having been President of the British section at the Exhibition at Antwerp, the Exhibition at Liege, and at the first Exhibition in Brussels, and a member of the Royal Commission for the recent Exhibition in regard to which such great assistance was rendered by M. le Duc d'Ursel. These exhibitions were most successful. They put before the world the products so necessary to the existence of all of us, and they entertained and instructed vast numbers of people, and therefore I think that in saying what I have done of the Belgian section, and of Belgian exhibitions, I may be taken to have spoken from some little experience. Now just a word with regard to the Congo itself. I re-echo the words of the Chairman that there may have been a time when there was criticisms, not only in our country, but in your's, which were, I think, frequently based upon misapprehension, and without a sufficient realisation of the fact that to govern native peoples from a very distant base, is a very difficult task. There are conditions in our own country and elsewhere which always make it difficult to avoid critical observations ; but if, as I believe, the best was done by Belgian statesmen, and if the result is now to develop reforms, which, according to the paper which has been read, are resulting in an excellent administration with freedom of labour, and the natives all free men, then I think that those who were critical in the past will be the first to welcome—with sympathy for the young King and the Belgian people—the result which has been brought about. (Applause.) That sympathy with freedom which we all feel may be said to be specially shared by myself, because my first knowledge of your late King, whose friendship I enjoyed for many years, was when as Mayor at Hull—the town of Wilberforce, the slave liberator—I went with an address from the Municipal Council and an introduction from Sir Henry Stanley—an address of congratulation on the foundation of the Congo State and of hope that it would tend to that freedom which was enjoyed by European people. I think it cannot be said that my sympathies

were in any other direction than the promotion of freedom. One who brings the message that that freedom is accomplished in the Congo cements anew the old feelings of regard between the Belgian and English people, and we welcome him with the greatest heartiness, as indeed we do all who come from a friendly country trading with us. (Applause.) Just as he was good enough in parts of his paper to praise our institutions, so we ask you from Belgium—M. le Duc and others—to carry back messages of pleasure, of encouragement, hope and satisfaction that difficult political problems in distant centres of the world have been solved, and that the end is to be the betterment of the trade of all peoples, the honour of Belgium, and goodwill even in a greater degree than in the past on the part of our own country of England. (Applause.) I move that resolution.

The CHAIRMAN: Mr. Herbert Wright, Editor of the "Rubber Journal," will kindly say a few words in seconding the motion.

Mr. HERBERT WRIGHT: I had no idea that I was to be asked to second the resolution which has been proposed by our friend, but I can only say that it gives me more than usual pleasure to take advantage of the opportunity. During the last two years I have had many opportunities of coming into close contact with our President and the various gentlemen whom I see here to-day, and during that period I have been much impressed by the business capabilities, friendliness, and integrity of the people whom I have met in Belgium. It is on that account I am glad to have the opportunity of seconding the resolution. I only hope we shall have at some not distant date a further opportunity of welcoming our Belgian friends. (Applause.)

The resolution was carried with enthusiasm.

Mr. McEWAN: We cannot leave this room without according to the Chairman our thanks for his services. (Applause.) I am sure you all agree that those connected with rubber in England and those connected with the Rubber Growers' Association in London are under a debt of gratitude to M. Bunge and the Association of Rubber Planters' of Belgium, who have done so much to co-operate with the English and with the English Colonial work. One of their earliest acts was to elect as corresponding members many of the members of the London Association, and last year the Planters' Association of Belgium were good enough to entertain a delegation from London at the Brussels Exhibition, of which I was pleased to form a part. I think you will all concur in according a very hearty vote of thanks to the Chairman to-day, who has been the means of bringing before us a lecture which took our thoughts away from rubber downstairs to philanthropy in connection with the Congo. I am sure it has been with the greatest possible gratification we have been able to hear at first hand testimony to the fact that things in the Congo have now much improved.

The resolution having been carried with acclamation, the CHAIRMAN acknowledged the compliment, and the proceedings terminated.

The Presidents, Monsieur E. Bunge and Monsieur E. Pollet, and the Committee for Belgium, entertained Mr. A. Staines Manders and Miss D. Fulton to dinner at the Savoy Hotel.

MALAY DAY.

THURSDAY, JUNE 29TH.

On Thursday, June 29th, a reception was given by the Malay States Development Agency in the large Reception Hall in the gallery. Sir Wm. Taylor, K.C.M.G. (Agent of the F.M.S.A.), welcomed the guests, and amongst those present were Sir Henry Blake and Lady Blake, Sir Walter Napier, General Cargill, Sir Wm. Adamson, Lt.-Col. Prain, Dr. Wilson, Dr. W. Carnegie Brown, Prof. Schidrowitz, Capt. A. E. Johnson, D.S.O., Mr. John Turner, Mr. Malcolm Cumming, Mr. A. Lampard, Mr. J. L, Loudoun-Shand and his son, Mr. W. E. Loudoun-Shand, Mr. H. Abrams. Mr. J. A. MacGregor, Mr. R. F. Grey, Mr. R. W. Harrison, Mr. J. Mactaggart, Mr. F. Mitchell, Mr. C. McRitchie, Mr. and Mrs. Hampshire, Mr. A. L. Bains, Mr. E. A. Watson, Mr. M. Duncan, Mr. C. Alma Baker, Mr. L. C. Brown (Inspector of Cocoanuts, F.M.S.), Mr. N. Dalrymple, Mr. W. Nicholas, Mr. J. W. Barker (Kepontg), Mr. F. N. Price, Mr. A. M. Burn-Murdoch (Inspector of Forests), Mr. T. S. Baker, Mr. H. de Z. Lancaster, Mr. and Mrs. A. S. Baxendale, Mr. W. Turing Mackenzie, Mr. and Mrs. A. G. Angier, Mr. A. L. Ingall, Mr. Robert J. Parkinson, Mr. W. H. Cochrane, Mr. E. L. Lauder-Watson, Mr. T. Carritt, Mr. M. J. Mitchell, Mr. S. Behr, Mr. M. Kelway Bamber, Mr. E. T. C. Garland, Mr. H. C. E. Zacharias, Mr. H. Hamel Smith, Mr. C. A. Leicester, Mr. O. A. Kimmel, Mr. E. S. Grigson, Mr. E. G. Salmon, Mr. Gerald Fitz-Gibbon, Mr. W. Slater, Mr. G. H. Golledge, Mr. and Mrs. Pugh, Dr. C .Christy, Dr. Fritz Frank, Prof. P. Carmody, Mr. K. Memmler, Mr. G. M. Stevens, Mr. M. Duncan, Mr. L. Brown, Mr. E. W. Davy, Mr. Fraser, Mr. Waller, Mr. Skinner, Dr. H. Stevens, Mr. H. H. F. Stockley, Mr. H. Caldicott, Mr. G. B. Leechman, Mr. Gordon Brown, Mr. J. Gardiner, Mr. W. S. D. Tudhope (Gold Coast), Mr. Stamford Raffles, Mr. F. A. Stockdale (British Guiana), Mr. H. F. Browell, Mr. Arnold Wright, Mr. F. M. Elliot, Mr. D. S. Hunter, Mr. A. Stewart Rennie, Mr. A. Staines Manders (the manager of the Exhibition), and Miss D. Fulton (the Secretary).

Sir Wm. Taylor was assisted by Mr. F. J. B. Dykes (Deputy Agent, F.M.S.).

Tea having been served, a photograph was taken and Mr. John Turner took the opportunity of making an announcement. He said: It will interest many here to know the result of the awards given in connection with this Exhibition. There were thirty governments represented, and sixteen awards have been made, of which British Malaya has got nine. (Loud Applause.) Nine awards out of sixteen is a thing Malaya should be proud of. (Renewed applause.)

Mr. MALCOLM CUMMING said: I have been asked very hurriedly to say a few words. I have not prepared any speech, but I suppose I must say something with regard to the rubber industry in Malaya and Ceylon, or the Middle East generally. You have heard that Malaya has taken nine prizes. Well, the beuaty of that is that it proves that our rubber is of some value, and is of use to the manufacturer. What I wish particularly to point out is that the present reduced price of rubber is not

on the whole, unsatisfactory to the planters of Malaya, because each week we see hundreds of tons put up to auction, and this rubber is going directly into consumption. Many of you who own motor cars undoubtedly have some of your tyres made of the Middle East rubber, and not, as heretofore, entirely of hard Para. That, I think, is the feature of the position to-day ; that plantation rubber is now finding its way direct to the manufacturer. With regard to the price I do not wish to say anything at all. The price, of course, has fallen considerably, and no doubt there has been a great deal of disappointment amongst buyers of rubber shares, but let them stay quietly in their homes and not spend too much money in the meantime, and I think they will reap the benefit of not throwing their shares on the market. (Applause.)

This brought the proceedings to a close.

SATURDAY, JULY 1ST.

M. Cambon, the French Ambassador, visited the International Rubber Exhibition and was met by the French Consul, Mr. Staines Manders (the Manager of the Exhibition), and the members of the French Committee.

MONDAY, JULY 3RD.

Her Highness Princess Marie Louise of Schleswig Holstein, accompanied by Lady Blake and Miss Hawkes (lady-in-waiting), visited the Exhibition, and were met by Sir Henry Blake, the president, Mr. A. Staines Manders, the manager, and Miss D. Fulton, the secretary, who presented the Princess with a handsome bunch of flowers. The Princess then made a tour of the Exhibition, and at the Belgian Section was handed another beautiful bouquet of flowers by Miss Pollet, daughter of the Consul-General for Belgium.

CEYLON DAY.

TUESDAY, JULY 4TH.

On Tuesday, July 4th, a reception was given by the Commissioner (Mr. E. Rosling) and Committee of the Ceylon Section. The large number of guests were received by Mr. and Mrs. E. Rosling, who were assisted by members of the Committee, in the large Reception Hall in the Gallery, and amongst those present were :—The Right Hon. Lord Elphinstone, the Right Hon. Sir J. West Ridgeway, Major-General Sir Chas. F. Hadden, Sir Wm. Taylor, K.C.M.G., Sir Daniel Hamilton, Mr. Rosling, Junr., and Miss Rosling, Mr. H. Powell, Mr. A. H. Kerr, Mr. and Mrs. Bibby, Mr. G. B. Leechman, Mr. and Mrs. R. Edley, Mrs. Stephens, Mrs. Laing, Mrs. Hodgson, Mr. and Mrs. W. Sinclair, Mrs. Johnston, Mr. and Mrs. R. W. Harrison, Mr. H. Hamel Smith, Mr. and Mrs. Cyril Baxendale, Mr. McEwan. Dr. Orchard, Dr. C. Christy, Mr., Mrs. and Miss Freudenberg, Mrs. R. H. Lock, Mr. and Mrs. F. Crosbie Roles, Mr. R. J. Booth, Mrs. E. Padwick, Mr. O. Devitt, Mr. and Mrs. Bethune, Dr. H. Stevens, M.A., Mrs. Morison, Mrs. Massy, Mr. Bremar, Dr. Fritz Frank, Mr. and Mrs. R. K. Ritchie, Mr. T. H. Williams, Mr. R. T. Cooke, Mr. J. D. Taylor, Mr. W. H. Cochrane, Mr. Ladewig, Mr. and Mrs. Joseph Fraser, Mr. and Mrs. Masfield, Mrs. and Miss Watt, Mr. J. Bryan, Mr. Eric O'Donnell, Mrs. Mackintosh Smith, Mr. G. S. Salmon, Mr. J. S. Bontein, Dr. P. Schidrowitz, Mr. and Mrs. Neville Priestley, Mr. and Mrs. W. C. S. Inglis, Mr. I. Dick Lauder, Mr. R. Bridge, Mr. L. Radclyffe, Mr. and Mrs. Wright, Misses Wilson, Mr. and Mrs. J. L. Loudoun-Shand, Monsieur L. Osterrieth, Monsieur R. Erhardt, Mr. Andrew Haes, Monsieur E. Pollet, Mr. A. H. Reid, Mr. Crewe, Mr. and Mrs. J. F. Robertson, Mr. H. A. Bume, Mr. A. D. Callander, Mr. H. Tindall, Mr. E. Johnson, Prof. and Mrs. O'Donnell, Mr. A. L. Hutchison, Mr. C. Henly, Prof. P. Carmody, Mr. C. Taylor, Mr. and Mrs. L. A. Martin, Mr. H. W. D. Morison, Mr. W. Morison, Mr. H. A. Wickham, Monsieur M. Brett, Mr. and Mrs. James Ryan, Mr., Mrs. and Miss Easton, Monsieur O. Dupuy, Mr. W. S. D. Tudhope, Mrs. Jenkins, Mrs. Grater, Mr. and Mrs. McKenzie, Mr., Mrs. and Miss Kelway Bamber, Mr. H. E. W. Cooper, Mr. J. R. Tyers, Mr. H. Neill, Miss Neill, Mr. W. C. Coleman, Miss Walker, Mrs. A. Hargreaves, Mr. and Mrs. I. A. Spence, Mr. I. G. van Hemert, Mr. R. Fyffe, Mr. Chas. Grenier, Mr. A. S. Collett, Mr. and Mrs. P. D. Warren, Mr. L. Boustead, Mr., Mrs. and Miss Jackson, Mr. L. Schopper, Mr. and Mrs. S. Morris, Mr. J. M. Smith, Mr. and Mrs. F. H. Layard, Prof. Wyndham Dunstan, Mr. H. T. Baines, Mr. W. M. de Meel, Mr. Marshall, Mr. H. F. Armitage, Mr. A. T. W. Taylor, Mr. J. Pow, Mr. Henry Baines, Miss Baines, Mr. I. W. Gasset, Mrs. A. Staines Manders, Mrs. W. Kirkby, Mr. Freudenberg, Mr. C. Griffin, Mr. A. J. Gordon Field, Mr. N. G. Bonaparte Wyse, Mr. W. C. Bonaparte Wyse, Mr. J. Cecil Cox, Mr. J. Ransome, Miss V. G. Ransome, Mr. R. H. Ferguson, Mr. R. Campbell, Mr. H. G. Maddocks, Mr. Wm. Coutts, Mr. A. C. Wright, Mr. J. C. Harvey, Mr. T. Petch, Mr. D. Dissawe, Mr. D. C. Hunter, Mr. G. G. Anderson, Mr. G. Stehn, Mr. G. H. Golledge, Mr. W. D. Campbell, Mrs. Bennett, Miss Bennett, Mr. Hatherell, Mr. I. F. Rea, Mr. W. A. L. Rowland, Mr. W. F. Robertson Reids, Mr. W. M. Seligmann,

Mr. A. Pelly Foy, Mr. Rowland, Mr. C. S. Banter, Mr. and Mrs. Spearman Armstrong, Mr. J. A. R. Clark, Mr. W. Emery Stank, Mr. and Mrs. Allanson Bailey, Mr. L. J. Jarvis, Mrs. Edward Ames, Mr. W. I. Keywer, Mr. and Mrs. Innes Lillingston, Mr. Carr Hamond, Mr. J. F. Foster-Melliar, Mr. C. J. Adam Thwaite, Mrs. J. Adam Thwaite, Miss Robinson, Mr. and Mrs. Templer, Mr. D. H. Michie, Miss Michie, Mr. and Mrs. Grey, Mr. and Mrs. O'Dell Figg, Mr. T. M. Lusk, Mr. and Mrs. E. L. Mansergh, Mr. R. Wade Jenkins, Mr. Murray Mengus, Mr. T. Gidden, Mr. A. Collingwood Smails, Rev. W. R. Peacock, Mr. G. S. Geake, Mr. E. F. Pfaff.

During the afternoon some valuable "Notes on Tropical Agriculture in Ceylon," were given by Mr. M. Kelway Bamber, F.I.C., F.C.S. (Government Analytical Chemist, Ceylon), who said:

Ceylon is essentially an agricultural island, the only mineral mined to any extent being plumbago. Although Ceylon embraces only 25,000 square miles (rather less than the size of Ireland), and is situated within a few degrees of the equator, it has a great variety of climatic conditions, thus enabling many tropical and sub-tropical products to be grown to advantage. The chief native grown products, confined more or less to the plains and lower hills, are paddy (rice) and coconuts. The former, covering some 620,000 acres, is still grown in the old-fashioned way of many centuries ago, and until comparatively recently without the aid of artificial manures, the plants and soil being maintained by the irrigation water cleverly brought by the Singhalese from the hills near or distant. Experiments for improving the yield of paddy have and are being conducted, but as there is little available capital for artificial manuring, improvement will have to be chiefly by methods of selection and more careful planting, and a system of green manuring, involving little more than extra labour on the part of the natives themselves.

Coconut cultivation covers 800,000 acres and is chiefly near the sea coast, though estates are extending inland. It was mainly confined to natives, but of late years has been more taken up by Europeans. Scientific agriculture is being brought to bear generally on the product with excellent results, few trees responding better to careful cultivation and manuring, although the improved results can only be obtained after two or three years. The extension of this product in the East is now rapid, owing to the rise in the price of copra from the demand for the oil for edible as well as soap-making and other purposes. The cultivation of the coconut palm has always been considered the safest investment in the East and, to those who know the Tropics, affords a sound investment for many years to come.

Cinnamon is another native product, which in former years furnished a large export. Its cultivation has, however, largely decreased of later years, coconuts and rubber yielding a more profitable return per acre. Citronella cultivation is also carried on by natives in the south of the island. Besides these products, tea, rubber and cocoa are grown in the low country or hills, their cultivation being mainly, though not entirely, in the hands of Europeans.

Tea thrives over a wide range from almost sea level to 7,000 feet, and its cultivation covers 400,000 acres. No product has received more careful and systematic cultivation and manufacture, and the industry to-day is in a most flourishing condition from every point of view. A few years ago cultivation was the exception rather than the rule, and the bushes were deteriorating over a large area. The whole aspect of

the tea districts of Ceylon has changed with this cultivation, arising from the system of green manuring with tree forms of leguminous plants. Formerly, the monotony of the bushes on the rounded and steep hills was only broken by occasional wind belts of grevilleas or eucalyptus trees imported from India and Australia. Now, many of the fields are covered with albizzias, dadaps, or acacias, according to the elevation, all of which are kept pruned at a few feet from the ground, the leafy material being utilised to replace the organic matter lost in many years under coffee or other cultivation. The effect of this on tea is remarkable and has done far more to insure the permanence of the product than any form of artificial manuring, while it enhances the effect of the latter.

A considerable area of tea in the low country has been planted up with rubber, with the result that it has gradually gone out of bearing as the shade of the trees increases. But the knowledge gained of the effect of green manuring and the discovery of new leguminous plants, has enabled other areas of land at higher elevation to be brought under cultivation, with every prospect of profitable returns as from the original forest lands. It has been conclusively proved that the rational application of artificial manures, together with the systems of cultivation now in vogue, not only increases the yield, but enables the bushes to regain that quality of leaf which was at one time undoubtedly being lost. The manufacture of the leaf has also undergone several improvements in machinery and methods, from the careful regulation of the withering to the sorting and packing of the finished article. In the former the conditions are such as to produce a more even wither in a definite period, while the fermenting stage, in which most chemical changes take place, is regulated under conditions of temperature, moisture and asepticism, which all conduce to more satisfactory results. Improvements in drying machinery have also been made, which, while insuring a good output, prevent to a large extent the loss of flavour or essential oil.

The cultivation of Hevea rubber on a large scale, some 240,000 acres, is a matter of only a few years, and I need not go into its development. Ceara has been grown in Ceylon for many years, but was originally planted in the tea districts where the rainfall was too heavy for its successful cultivation. There are, however, large areas of forest land in Ceylon, where both soil and climate are suited for this product, and with more successful methods of tapping, which are being secured in Ceylon and Africa, the future of this product is promising. The other varieties of Manihot recommended by Dr. Ule, of Brazil, do not show much promise in Ceylon up to the present. M. dichotoma grows fairly well, but is useless where any severe wind is experienced ; while M. pianhyensis and M. heptaphylla, have proved quite unsuitable. It may be of interest to many who own such rubber to know that seed from ten months old trees gave far more satisfactory results as regards germination and growth, than those from two year old trees, and this may account for the poor germination obtained from most imported seed, which was probably collected from old trees.

With regard to the cultivation of Hevea, experience is rapidly being gained for its successful manuring not only for increased growth, but for better bark renewal ; and I have no doubt the cultivation of this valuable product in Ceylon will be done on scientific lines as in the case of tea, and so make it as permanent as that industry.

The chief aim of all interested in the industry in Ceylon is, while obtaining the best yields, to give a clean product that will best suit manufacturers' requirements. At the first exhibition, held in Peradeniya, in 1906, and the second at Olympia in September, 1908, and again, now, we are endeavouring to ascertain in what form the manufacturers would best like the rubber sent ; but while there is, and always will be, a healthy competition between superintendents of different estates to produce the best article, and buyers continue to take all kinds (crepe, biscuit, sheet, block) at profitable rates, the production of rubber by one uniform method will remain unsolved.

With the increased areas coming rapidly into bearing, manufacturers can now, however, obtain larger parcels from individual estates, and rely on the same quality arriving throughout the year ; but for the largest buyers the want of uniformity in large bulks is no doubt a factor which at present minimises the use of plantation rubber. It is for planters to realise that any variation in a break, or in the weekly output from an estate taken by one buyer, may have disastrous results on the finished vulcanised article and create a lack of confidence in the manufacturer, resulting naturally in a lower price being obtained.

I am informed that plantation rubber is rapidly growing in favour with manufacturers who have modified their mixtures and conditions of vulcanisation to suit its requirements, and it only remains with planters to do their utmost to render their output, in whatever form it may be, uniform from one year's end to another, so that buyers may always rely on getting a definite standard that will always vulcanise perfectly under the conditions they have found most suitable.

Much has still to be learned regarding this new industry, and it is evident to all that many useful lessons can be learned from the present Exhibition.

Mr. E. Rosling, Commissioner, and the Committee from Ceylon, entertained Mr. A. Staines Manders and Miss D. Fulton to dinner at the Carlton Hotel.

Dinner of the West India Committee.

WEDNESDAY, JULY 5TH.

A dinner was given by the West India Committee on Wednesday, July 5th, at the Exhibition, and was largely attended. The Hon. R. A. S. Warner, K.C., Solicitor-General of Trinidad, presided, and there were present the Hon. S. W. Knaggs, C.M.G., Colonial Secretary of Trinidad and Tobago, Hon. W. H. Lascelles, His Honour R. S. Johnstone, Chief Justice of Grenada, Dr. Jacques Huber, Professor P. Carmody, F.I.C., F.C.S., Director of Agriculture, Trinidad and Tobago, Mr. F. A. Stockdale, F.L.S., Assistant Director of Agriculture, British Guiana, Mr. Kelway Bamber, Mr. R. H. McCarthy, C.M.G., Mr. T. Petch, Mr. Edgar Agostini, K.C., Mr. R. Fyffe, Uganda, Mr. H. S. Smith, Mr. H. A. Wickham, Mr. Carl Wieting, Mr. Luke M. Hill Mr. W. C. Tudhope, Director of Agriculture, Gold Coast, Mr. J. C. Harvey, Southern Mexico, Mr. C. Cary Elwes, Mr. H. Godrich, Hon. A. D. Lockhart, Mr. Hamilton Burt, Mr. Oliphant Devitt, Mr. George Williams, Mr. A. N. Homer, Mr. A. N. Lubbock, Member of the Executive of the West India Committee, Mr. E. A. H. Haggart, Mr. B. H. Stephens, Mr. W. M. Botsford, Mr. David Hunter, Mr. T. J. W. C. Davenport, Mr. L. Lambert Bell, Mr. E. L. Marshall, Member of the Executive of the West India Committee, Mr. Mackintosh, Mr. M. A. D. Cillard, Mr. George Springe, Colonel S. Sandbach, Mr. W. G. Richardson, Mr. H. Powell, Mr. T. E. Miller, Mr. H. E. M. Johnstone, Mr. Randolph Rust, Mr. W. T. Gillingham, Mr. F. W. de Valda, Hon. Hamilton Rolle, Mr. H. Hamel Smith, Mr. A. Staines Manders, Major E. B. Walker, and Mr. Algernon E. Aspinall, Secretary of the West India Committee.

The loyal toasts having been duly honoured,

The CHAIRMAN, who was received with loud applause, said: I think you are all aware that this dinner has been organised by the West India Committee for the purpose of calling attention to the capacity and producing of India-rubber by the West Indies, and particularly the four colonies represented at this Exhibition, namely, Jamaica, Trinidad and Tobago, Demerara, and Dominica. Before I deal with the subject of rubber in particular I should like to say a few words about agriculture in general in the West Indies. My remarks will necessarily be cursory, but I think they may be of some use probably in removing false impressions that may rest amongst some people in this country, though I am satisfied that you gentlemen are under no delusion as to the facts. It may not be known here in England the extent to which the West Indies has for some years taken to agriculture seriously. I dare say a great many people are unaware of the fact that apart from the efforts of planters, and of the ingenuity, effort, energy and capacity they have put into their work, there have been Government Departments of Agriculture, aided by Boards of Agriculture, fully equipped with an expert scientific staff, comprising mychologists, entomologists, bacteriologists, and all those persons whom the world has come to understand to be absolutely necessary to the prosecution of agriculture in an intelligent and prosperous way. They have undoubtedly been doing all they

possibly can to make their agriculture a success. (Hear, hear.) In illustration of that I wish to refer to what has been done by one of the colonies. I refer to Trinidad, and throughout my remarks you will pardon me if I exclusively refer to Trinidad, as that is the island with which I am most acquainted, and not because I have any desire to put it before the others. In connection with the remark that agriculture in the West Indies is being followed up on more up-to-date and modern lines, I may mention the fact that Trinidad was so anxious to get the best advice on the subject of rubber that they succeeded in getting Mr. J. B. Carruthers to come from the East to Trinidad as Assistant Director of Agriculture to give us the benefit of his best experience on the subject. Unfortunately Mr. Carruthers lived but a short time after his arrival—I think it was a short ten months—but in that time he threw himself heart and soul into the cultivation of rubber, and being, as we called him, in a friendly way, "The Optimist," he succeeded in enthusing others, and instilling into the planters and the community generally a belief in the future of rubber, which we believe will serve us in good stead in prosecuting its cultivation to a successful issue. That I mention merely as an instance that we are very much in earnest. Then there exist in all these colonies what is known as Permanent Exhibition Committees. They owe their origin to a very wise suggestion from the West India Committee, which, as we are all aware, is never tired—under the guidance of its indefatigable secretary, Mr. Aspinall — of making happy suggestions to the West Indies and doing what it could to help the West Indies to prosperity. This appointment of Permanent Exhibition Committees has proved a very excellent one, because it enables these colonies to have ready for any exhibition that comes along, either in England or elsewhere, at any time, that which will adequately represent the colonies. I do not wish to mention names, but I wish to call attention to the existence of these Committees as being of enormous value, enabling us to be represented on occasions such as this in a way in which I think every one who takes an intelligent interest in it is sincerely proud of. (Hear, hear.) I trust those who come to the Exhibition will realise that we are alive, active and not wanting in energy, but that on the contrary we have done a very great amount of hard work and real enterprise. (Applause.) This brings me to refer to the history of rubber in the West Indies. Speaking generally of cultivated rubber—I am not referring to the rubber obtained from the aboriginal trees from which balata is obtained—it began to be cultivated in the islands where cocoa grows. It was run in between the cocoa, and planted in places where cocoa would not grow. Of course, that was not very wise, but it was the sort of thing that was done. When a man is cultivating a profitable crop, such as cocoa, he is only inclined to plant rubber so as not to interfere with the cocoa. It, of course, was not fair to the rubber ; but rubber growing started in that way. The planters had not the capital to lay out in special rubber plantations. Still, the trees have been grown to dimensions that will enable us to tap them. I am not going into figures—I do not think it safe to do so—but I may say that the results have been eminently satisfactory and it has given us sufficient latex to produce such samples as we show here as specimens of what the West Indies can do. Although from the point of view of the individual planter the mixing of the crops may not have been a wise thing—though I do not say he will not get his profit out of it—the result has not been altogether unsatisfactory. Rubber has been produced—principally *hevea* and *funtumia*. *Castilloa* is the rubber which was native

to Central Africa, and that was the rubber we naturally started with. From the "Trinidad Bulletin" I find the estimated number of trees in the colony to be something like 600,000 *Castilloa*, 80,000 of *hevea*, and something like 25,000—though I think myself the number should be 40,000 *funtumia*. As to *funtumia*, I do not know that we know much about it, because it will not produce latex. As to the treatment of the latex of the other two, we have every reason to be satisfied with the progress we have made up to to-day. In reference to *Castilloa*, I think it is a matter that should have some attention directed to it, and I wish to read to you an extract from a report written by Mr. Carruthers. In the short time he was in Trinidad he issued one short preliminary report. No doubt that would have been followed by more detailed reports later on, and it is for that reason, amongst others, we bewail his loss. Still, that report gave us courage to go on and to stick to the enterprise and try to make a good thing of it :—"Observations in different parts of Trinidad and Tobago lead me to the belief that *Castilloa* and *Hevea* (Para) grow equally well and vigorously here. It is true that in places *Hevea* seems to thrive more than *Castilloa*, but the reverse can be observed and I do not think there is any reason to suppose that taking the island as a whole either plant grows more vigorously than the other." Then he says :—"The results of all observations and experiments which have been carried on in Trinidad and Tobago are most encouraging in regard to the amount and quality of the latex in the tissues of Castilloa trees of age and size, but the methods of extraction are at present by no means satisfactory." Further on he said :—"It is, however, certain that both *Hevea Brasiliensis* (Para) and *Castilloa Elastica* grow vigorously and yield latex in good quantity in Trinidad and Tobago. No data exists as to yields, only spasmodic tappings having been made and no rubber has been prepared but by the crudest methods, but all these attempts have been encouraging and contain no evidence that the trees of Trinidad and Tobago possess any less of the profitable characters than the Para and Castilloa trees of rubber-producing countries." Now I do think that this was worth quoting because he was quite an eminent and independent authority, a man who came at the very moment, as it were, from the East, from a country where rubber was already an assured and established product and coming from him, therefore, it is valuable evidence that anyone anxious to ascertain the prospects of the West Indies in the matter of growing rubber profitably could not ignore but rather place the greatest value upon. Tapping was a difficulty. It would seem that the *Castilloa* trees were about 16 to 17 years old—it may be there are some older in Tobago, which was the first island to plant *Castilloa* consistently. Their origin in that island was due to the fact that sugar had gone out of Tobago, and they had taken to put in cocoa. At that time rubber was being much spoken of, and having the land they decided to try rubber. The same thing did not exist in Trinidad because the cocoa was already prosperous there, and when a man is doing well with one cultivation he is not so ready to try a new thing, however promising. You may say, of course, that that is not wise of him, but it is so ; human nature being human, and especially human when capital is limited. So the planters of Trinidad went on with the planting of cocoa and did not embark so soon upon rubber ; and that is the reason why Tobago was in advance of Trinidad in the cultivation of *Castilloa*. Then, the trees having grown up, the question of tapping came to the front, and great difficulties arose. At first they tried to tap *Castilloa* as you do *Hevea*,

namely, on the herring-bone system, and found that that was not the right way in which to tap *Castilloa*. They found that the structure of *Castilloa* was entirely different to the structure of *Hevea*, and that it was necessary to find another method. At the time Professor Carruthers wrote not so much was known on this point as is known now— and I think we are confident now that at last we have the right method. As compared with the eastern method of tapping *Hevea* it may seem a little crude and at the same time a drastic method of treating the tree, but I understand the tree bears it perfectly well. No doubt the method of tapping *Castilloa* will be developed and improved in the same way that the method of tapping *Hevea* has been developed and improved; but we have got to the stage at which even with our crude methods of tapping the *Castilloa* can be made to yield a large amount of latex, and that is something. The next question that arose was as to the way of treating the latex, and that we claim absolutely to have finally settled. I do not say that the method is not capable of improvement, but through the energy and ingenuity of Mr. Smith, of Tobago (applause) we are in possession to-day of a machine of a centrifugal nature. I am not much of an engineer so you will pardon my not explaining it in a more technical way, but it operates in a centrifugal way. There are in this exhibition samples of the rubber produced by it; and I may say that a broker—I have no right to mention his name—informed Mr. Aspinall and myself and a great many others who heard him—he has also been good enough to supply me with his opinion in writing, which I have here now—that that rubber is a rubber which if he had not known it was *Castilloa* he would have believed it was *Hevea*. (Hear, hear.) Now, gentlemen, I do think you will agree with me that that is a fact of the first importance. We have not yet produced large quantities, but that will come, but here we have produced from a machine invented in the West Indies, rubber of such a nature that it is declared to look equal to *Hevea*, and not merely so in appearance but also as the result of examination. It is therefore, I submit, very encouraging (applause) especially coming, as it does, from an independent source.

The next point that occurs to me is as to this Exhibition, of which the West Indies forms only a very small part. To me this Exhibition is a most instructive and encouraging one. It is a most delightful thing to find all the nations of the world who produce rubber sending their products here. It is an Exhibition not only by producers but users of rubber, and so it will afford opportunities to the planter of supplying just what is required and of the standard which is required. It forms a grand opportunity for everyone to see what is wanted; and it will enable the producer to satisfy the purchaser. Therefore I say it is a most cheering and exhilarating Exhibition. Anyone who takes an interest in these things must be especially interested in the exhibits from Malaya and Ceylon. To me they seem to give great evidence of energy and grit and the wise investment of capital. Not only must Malaya and Ceylon be proud of their exhibits, but everyone in the world must be proud of them also. Especially here in London should British subjects be proud of them (applause) because one is inclined in these matters to realise that the work of one man is not only for his own benefit, but for the benefit of others, and we, with our insignificant part of the Exhibition, must say that we are in a position to benefit by what we have seen from Malaya and Ceylon, and to take heart and go away determined to do the same. What we have done may seem little beside the accomplishments of other countries, but we can claim that we have

emerged from the experimental stage. Is not the West Indies the home of rubber? Are not the Amazon and the Orinoco the home of rubber? We know we can grow it, and that it will meet the requirements of the world. That is surely a point to be thankful for. What we have to do is to go on and increase our output. It is no longer being only grown amongst cocoa. People feel that they must devote their best land to it, work it as a cultivation by itself and do justice to it, giving it fair play. I avoid touching on figures—they are too dangerous—but a large number of rubber plantations have been laid out on lines suggested by Mr. Carruthers, who was always ready to help and advise. Planters are doing their best to follow the brilliant example set by Malaya and Ceylon. They are, so to put it, our big brothers—brothers who have gone out into the world and succeeded. We are proud of them and are not envious. We respect them and are going to learn a lesson from them and see if we also cannot be a matter of pride to the people who stay at home and do not plant anything anywhere. (Applause.)

I may be asked why we are behind; why we did not start earlier? Sensible people knew rubber was a good thing, why is it that the West Indies are so far behind? As I have said, we have had *Castilloa* trees for a large number of years. Well, what stopped us was not a lack of energy, but a lack of the knowledge of the right way to tap *Castilloa*. We have got over that now, and can send our produce to the market in a uniform and acceptable manner. But the most important reason why the West Indies has not gone in more for rubber is the want of capital. We here all know—though no doubt the man in the street does not—that the West Indies as a whole, and individually, are really now quite prosperous owing to the action of that great statesman, Mr. Chamberlain. (Applause.) We have been set upon a firm commercial basis. The competition of foreign countries no longer exists, and we have no extraneous and unfair competition to meet. As regards the sugar industry, I believe it is now on a sound and paying basis. But such capital as there now is in the West Indies available for agriculture is locked up in the established industries. The capital of the sugar planter is in sugar; and the capital of the cocoa grower is in cocoa; there is no loose capital seeking fresh investment. It is an old story, this want of capital. I am not crying over it. The West Indies are doing well; we are proud of their prosperity. We are confident there is a great future before them. (Applause.) In a thousand and one ways the West Indies are going ahead. One the other day was able to pay £20,000 a year to bring the royal mail service to the West Indies. In another place we know that oil has been discovered—(laughter and applause)—and in numerous ways we all must feel that the prosperity of the West Indies is an assured thing. All we need is courage and pluck to develop them. Still, this question of capital is important to us. If I may put it in this way, in England there seems to be more capital than opportunity; in the West Indies there seems to be more opportunity than capital. (Applause.) We know there are large holders of money in England daily scanning the horizon to see where they can put a little bit more. Well, in the West Indies there is ample opportunity; and we hope that one result of this Exhibition will be to draw attention to this. The man with money in England pats his pocket and says, "See what we have done in Ceylon and Malay." Well, you can do the same in the West Indies. You can do it in a fortnight, for there is a fortnightly service with the West Indies; and if you will do for the West Indies what you have done for Ceylon and Malaya you can make a successful industry and pat your pocket

with some justification. And so I would beg of those who come to this Exhibition not to be content to see great successes. That is not the way to treat an exhibition. An exhibition is instructive. You should look not only for great successes, but for good opportunities. Realise that eight years ago Malaya was in this matter where the West Indies are to-day, and that of capital was attracted to the West Indies in another eight years the West Indies could be where Malaya is to-day. (Applause.) The same prosperity awaits capital there ; and remember that the West Indies contain some of the oldest possessions of the British Crown. There is no want of land. There are millions of acres in the Hinterland of Demerara and in the Hinterland of British Guiana—land essentially adapted to the cultivation of rubber and only waiting for capital. You have in the other islands, to a lesser extent, large tracts of fine virgin forests. Speaking of Trinidad, I think there is a third of the island still unalienated and of that perhaps two-thirds is fine rich land capable of yielding fine rubber crops. If capital could be directed there it would be a fine thing.

In conclusion, a word is due from me in explanation of how I come to be your chairman to-night. About 14 years ago I had the pleasure—I have always thought of it as a pleasure—of welcoming Mr. Aspinall, the Secretary of the West India Committee, in Trinidad, on an occasion when we went to see some young *Castilloa* trees, and, rightly or wrongly, he came to the conclusion that I might in a way be a sort of pioneer of the plantation of *Castilloa* in Trinidad. (Applause.) If that was true, I should be proud to own it ; but I can claim nothing more than that I was amongst the first to plant rubber there. Any credit due in that matter is due to Mr. Wade, a gentleman whose name must be familiar to most of you who have cocoa interests. (Applause.) He is a man whose name stands in the first rank of cocoa planters, and whose energy, ability, and hard work are proverbial. He was taken with the possibilities of rubber, and, as we say, ran it through his cocoa, if not to grow a double crop, at all events to learn what there was in rubber. Whatever credit there is for pioneer work is due to him. I have said it was a pleasure to me to meet Mr. Aspinall. It might be perhaps ungracious if I said that within the last day or two I have almost wished he had not come (laughter and applause) because if he had not I should not have been in this position to-day, inadequately performing these duties. ("No, no.") I feel that there are numbers of people here who know the subject from A to Z far better than I do. I can only speak generally as one who takes a great interest in it. Before sitting down I also wish to mention the name of Mr. Wickham. (Applause.) There are other names I ought to mention, but it is such a lengthy list that I am loth to begin. However, Mr. Wickham's name must be excepted, because he is the father of the rubber industry in Ceylon and Malaya. (Applause.) It was he who in the early seventies was the first to take seeds and plant them there. I congratulate him on the success that has followed that enterprise. I must not detain you longer. This evening, after dinner, we are to have a lecture by Mr. Stockdale, Assistant Director of Agriculture in British Guiana, in Demerara, and mentioning that reminds me that I should mention the names of the principal men in the Government Departments of Agriculture in the West Indies—Professor Harrison, a household name there, and Professor Calmody (applause)—to whose energy and perseverance we owe much of the success of this Exhibition. There are other gentlemen connected with the Dominica and Jamaica all of whom are doing, with the Departments and Boards, and the

Exhibition Committees, a great work in helping to advertise the colony, because, as we know, and as the Exhibition knows, without advertisement nothing can be done. It is absolutely necessary to advertise. I have been trying to do what I can and am proud to contribute my mite to bring the prosperity we all so devoutly hope for. I give you the toast of " Prosperity to the West Indian Rubber Industry."

The toast was drank with much enthusiasm.

The Hon. E. H. HAGGART: I rise to propose the health of our Chairman, and I am sure it is a toast which will be cordially accepted. When I was asked by the secretary to undertake this duty I asked myself why I, a stranger almost in London, coming occasionally from Jamaica, the last island on which his majesty the sun sets—the last sun-kissed realm of the west—to which his majesty the sun bids good-night, should have been selected. Looking around I wonder who comes from the further East to which the sun bids good-morning, and who hears the cock-crow first as the sun arises. I shall leave that gentleman to answer for himself. We have heard much said about the Federation—the Union—and I am sure you all feel it is a union desired by all. Though in the past the West Indies, so far away, have been largely forgotten, there is no reason why it should not speak and vote in the counsels of the Empire. There we are federated and united as colonists; with a desire to make the best figure we can before the world. It would be wrong and forgetful of me if I did not say that we have honoured names in the West Indies—names such as the Parkinsons—men who went there years ago; in Barbados the Austins; and in Trinidad the Warners. (Applause.) They have done much for the prosperity of the islands. You remember Sir Robert Warner, the founder of St. Kitts, an important colony? I was not born there, whereas many of you were; but I have always said that if I had not been born in Scotland I would have liked to have been born in Jamaica. My home and my heart is in Jamaica; in your own lovely island. Gentlemen, I give you the toast of our worthy Chairman, and I am sure I can convey to him in your name our thanks for his excellent speech, and for his magnificent occupation of the chair.

The toast was drank with much heartiness.

The CHAIRMAN having acknowledged the compliment, and a suggestion having been adopted that a telegram of congratulation should be sent to Mr. Chamberlain, this portion of the proceedings terminated.

NOTE.—After the dinner, F. A. Stockdale, Esq., B.A., F.L.S., gave an interesting lecture on the West Indies, with lantern illustrations. Particulars of this lecture will be found elsewhere (see index). ED.

The International Rubber Banquet.

The Connaught Rooms, Kingsway.

Friday, 7th July.

The International Rubber Exhibition Banquet was held at the Connaught Rooms, Kingsway, on Friday, July 7th, the chairman being Sir Henry A. Blake, G.C.M.G., the President of the Exhibition. On his right were the Brazilian Minister, His Excellency Don Regis de Oliveira, Mr. H. S. J. Maas, Consul-General for the Netherlands ; Sir Arthur Birch, K.C.M.G., Mr. E. Pollet, Consul-General for Belgium ; Mr. de Coppet, Consul-General for France ; Sir William Hood Treacher, K.C.M.G., Mr. A. Bethune, President of the Rubber Growers' Association ; Mr. W. Turing Mackenzie, Mr. J. L. Loudoun-Shand, Mr. H. A. Wickham, Mr. R. Ferguson, Mr. F. Pegler, M. Octave Dupuy, Vice-President and Delegate of the Indo-China Rubber Planters' Association ; M. Georges François, French Colonial Office ; Mr. Charles K. Musgrave, Secretary of the London Chamber of Commerce ; Dr. J. Huber, Commissioner for the State of Para ; Mr. H. Powell, Commissioner for the East Africa Protectorate ; Mr. W. S. D. Tudhope, Commissioner for the Gold Coast Colony ; Mr. J. M. Wotherspoon and Mr. F. A. Stockdale, Commissioner for British Guiana. On his left were Sir John Anderson, G.C.M.G., Permanent Under-Secretary of State for the Colonies ; Dr. H. Johannes, Consul-General for the German Empire ; Sir W. T. Thiselton-Dyer, K.C.M.G. ; Mr. Francisco Alves Vieira, Consul-General for Brazil ; Baron A. Heyking, Consul-General for Russia ; Sir William T. Taylor, K.C.M.G., Commissioner for British Malaya ; Mr. Stanley Machin, Chairman of the Council of the London Chamber of Commerce ; Mr. Edward Rosling, Commissioner for Ceylon ; Dr. J. P. de Lacerda, Commissioner for the Union Government of Brazil ; Senor Emilio Zarges, Commissioner for the State of the Amazonas ; Dr. Busse, Imperial Colonial Office, Berlin ; Mr. R. K. Magor, Vice-President of the Rubber Growers' Association ; Mr. H. K. Rutherford, Past President, Rubber Growers' Association ; Mr. Norman W. Grieve, Sir Chauncy Cartwright, K.C.M.G., Mr. T. G. Hayes, Mr. John McEwan, Mr. Leonard Wray, I.S.O., Professor P. Carmody, F.I.C., F.C.S., Commissioner for Trinidad and Tobago, Director of Agriculture Port of Spain ; Mr. R. Fyffe, Commissioner for Uganda.

At the other tables were the following gentlemen (whose names are given alphabetically) :—Henry M. Alleyn, D. J. L. Anderson, Ian G. Anderson, Jayme de Argôllo Ferräo Jor, A. Ayris, A. C. Baber, Robert B. Baird, Robert L. Baird, Thos. A. Ball, Geo. M. Ballardie, W. B. Bartlet, Cyril Baxendale, Edward Bedford, Dr. A. H. Berkhout, Noel Bingley, Dr. W. R. Bisschop, Walter Blaess, Charles Blair, Robt. Bridge, E. E. Buckleton, R. A. Cameron, W. D. Campbell, Aug. Christensen, James A. R. Clark, F. Clement, W. H. Cochrane, Hon. Edward Coke, T. E. Cook, Stuart R. Cope, Frank Copeman, J. Cecil Cox, A. E. C. Detzey, A. Oliphant Devitt, Charles G.

Devitt, Geo. B. Dodwell, R. Ehrhardt, R. Ferguson, Bryan Figgis, A. Russel Fincham, G. Fitz-Gibbon, Harington G. Forbes, Joseph Fraser, Walter T. Fremlin, J. C. Gardner, Voorhoeve Gerard, Paulo Gerechter, W. Glass, G. W. Golledge, Sir Home Gordon, W. S. Gordon, Patrick Gow, C. Granville, N. Green, Chas. Grenier, Dr. Tromp de Haas, H. de Courcy Hamilton, J. C. Harvey, John Hay, R. Bruce Hay, T. G. Hayes, W. J. C. Hendrey, J. W. Hickson, G. J. Hill, P. Hill, D. Hunter, Mark W. Hydes, W. Lindley Hydes, James Labe, A. L. de Lalande, Henri Laloux, G. Langenberg, W. Martin Leake, P. Lippens, Stanley Machin, Thomas Mackie, — Maclachan, W. F. de Bois Maclaren, — Major, A. Stanes Manders, H. M. Mitchell, D. Miller, H. Eric Müller, Charles E. Musgrave, J. H. Nicholson, Wm. O'Malley, M.P., FitzAdam Ormiston, Leon Osterrieth, P. Osterrieth, E. Pfaff, Wilhelm Pahl, J. Pegler, K. Pfleiderer, W. Pfleiderer, E. Playford, J. E. Pocknell, H. E. Potts, H. Powell, Wykeham Price, Leslie Radclyffe, T. A. Richardson, Dr. Samuel Rideal, T. S. Roferson, F. Crosbie Roles, P. R. Rutherford, J. A. Ruys, E. G. Salmon (*Rubber World*), Col. J. C. Sanderson, Jacques Schad, Dr. Jules Schaller, P. Scheffer, Dr. Schidrowitz, W. E. L. Shand, Osman Shaw, W. A. Shepperd, Theodore Eugene Smith, Cyril R. Smithett, W. W. Smithett, Emil Spannagel, G. Springer, H. C. Stewart, C. B. Sutton, A. G. N. Swart, G. A. Talbot, C. Taylor, Roger E. Thompson, W. A. Tinnock, Dr. Torry, C. E. Town, J. Valentine, W. de Veer, H. L. Way, L. E. Wechel, T. W. Wilkinson, Charles T. Wilson, E. G. Windle, B. L. Seaton Winton, Herbert Wright, N. G, Bonaparte Wyse, H. C. E. [Zacharias, S. W. Zeverijn, Fritz Zorn, John Zorn.

The CHAIRMAN : Your Excellency and gentlemen, the toast that I have to propose is one that from time to time we have heard proposed without any observation at all, but I think when we remember that our King has only just gone through those tremendous ceremonies of his coronation and that the vibration of the acclamations of tens of thousands are still ringing in his ears, it may be well for us to consider for a moment what manner of man is he whom God has brought to rule over us. Well, gentlemen, happily we know his Majesty ; we have known him from a child, and every man who has ever come in contact with him acknowledges that he has met a true Briton and a man every inch of him. (Hear, hear.) His Majesty has been from his earliest childhood in the service of the State. I remember him when he was a young lieutenant serving on board the "Thrush" in the West Indies, and I remember on that occasion the Admiral of the Fleet telling me that he was the best young officer in his fleet. (Hear, hear.) He had no man to look after him. He was the senior officer of his ship, and he managed it himself without any leading-strings. I will tell you a story that I have heard from a very authoritative source of the King's early service. When he went on board his ship he looked over the list of the crew and found on the list one man whose record was extremely bad. He called him up and he said, "Look here, I cannot have a man like you in the crew. We cannot have a ship's company disgraced by a man like you. Here you are, 'Drunk,' 'Drunk and violent,' and so on, until at last you are unable to leave the ship. I will not have a man like you on the ship. Here, I tear this character up ; now let me see what you will do for yourself in the future." (Applause.) And I believe that from that moment that man was the best man in the ship's crew. Now, gentlemen, that shows that His Majesty knows how to deal with men, and I can tell

you that all those who have had the opportunity of knowing him say that there is not in this wide realm over whom his Majesty rules a man who is more devoted heart and soul to the realm than he is, or more devoted to the conscientious performance of the tremendous responsibilities and duties that rest upon him. (Hear, hear.) I give you the toast to his Majesty.

The toast having been loyally honoured,

The CHAIRMAN said: The next toast which I have to give you is that of "The Queen, Queen Alexandra, the Prince of Wales, and the rest of the Royal Family." I do not know that it is necessary for me to say but very few words in commending this toast to all the loyal subjects I see around me at this board. A great many of those who are at this table remember the time when that sweet young princess came over from Denmark, and the heart of the whole of England went out to her. The grace and beauty which distinguished her then has continued in the widowed queen to this moment, and I believe she still lives in the hearts of the people as she has done for many years. And what of our young Queen? We all know, gentlemen, that there is no branch of charitable interest that can be taken up in the welfare of the people, especially those relating to the women of the country, in which the Queen has not a dominant interest. And we may say of all the royal family that every one in their place is giving service heartily day by day and year by year to the country in the forwarding of every movement for the benefit of the people. Gentlemen, the toast I give you is "The Queen, Queen Alexandra, the Prince of Wales and the rest of the Royal Family."

The toast was drank with much enthusiasm.

The CHAIRMAN: Gentlemen, the next toast it has been given to me to propose is one that I propose with the most sincere pleasure. It is the toast—which I commend to you—of "The Ministers and other Official Representatives of the Nations taking part in the Exhibition." (Applause.) I do not know that it is necessary for me to say one word in commendation of this toast to any man who has been through this exhibition since its opening. I, myself, feel how much this exhibition owes to all those gentlemen for their courtesy and readiness to impart every kind of information to those who have gone through the various courts—those courts which have been fitted up with such extreme taste, and so ably as to show the various products as they require to be brought before the visitors to the exhibition. We all remember—a great number of us at least—that we were similarly indebted to a considerable number of our foreign friends at the last exhibition. At this exhibition we have welcomed those old friends, and we have also welcomed the coming of other men from foreign countries, and I hope everyone will find that the acquaintances that have been formed in the course of this exhibition, the giving and taking of information, will result in the acquaintances ripening into friendships that will bear fruit in the future. (Hear, hear.) Gentlemen, the advent of the exhibition of rubber from every rubber growing country in the world and the leaving of men in charge of these exhibits—the most intelligent experts, the best men that could be brought forward to look after the interests of their country and their department—is most gratifying. I hope that all these gentlemen, some of whom I see around me—old friends—I hope that as they have given us a great deal of most valuable information they will be able,

one and all, to take home something perhaps that they have learnt from us and from the exhibition, for we have had rubber from all over the world, and a great deal has yet to be learnt with reference to it. I know that when the time comes, as we all look to the end of the exhibition and ask ourselves what is the result—I hope and believe that these gentlemen who have favoured us by coming to this exhibition will be able to answer for themselves that it has been to them entirely satisfactory, as indeed it has been to us. Gentlemen, I ask you to raise your glasses and drink most heartily, with three cheers, the health of the ministers and other official representatives of the nations taking part in the exhibition, whom we most cordially and heartily welcome amongst us.

His Excellency the Brazilian Minister, who was received with applause, replied as follows: Being the representative of the country which sends the largest supply of rubber to the world's markets, it is my happy lot to have the honour of replying on behalf of my colleagues here assembled. I have ever been an enthusiastic advocate of international exhibitions, for they bring nations together and unite them by commercial ties, which are the strongest bonds amongst nations for creating real and lasting alliances. It was a great pleasure and gratification to me, on going round the Rubber Exhibition, to observe that my country, alongside the other countries producing rubber, occupies a prominent position. The way in which Brazil has come forward in this exhibition plainly shows the interest she takes in the cultivation of this important product of her exportation. But this interest does not stop here: I am informed that the Governments of the two States most concerned with rubber, I mean Para and Amazonas, have already promulgated laws for the regulation of the plantation of rubber, for the purpose of improving the process of preparing it now in use, and for the establishment of banks with the view of providing the owners of seringeaes, as they call rubber plantations in Brazil, with additional capital, so that the industry may be carried on with a smaller outlay. This indirect protection of the industry is, in my opinion, the only one which the Brazilian Government looks upon with favour, the artificial means by which the price of such a product could be raised, being undoubtedly fraught with considerable danger. Though this indirect protection may not be attended with such quick results, it nevertheless affords more strength to the market and opens out much better prospects of an enduring nature to the industry without all the attendant risks involved in an artificial method of raising prices, a process which is altogether antagonistic to the principles of economical science. I propose, now, gentlemen, the health of the Chairman.

The toast was drank with much enthusiasm.

The Chairman: I promised to give you very little of your chairman, but it is my duty to tell you that the Rubber Growers' Association of London, the Planters' Association of Ceylon, and the Planters' Association of Malaya have been desirous of recognising the work done many years ago by the authorities at Kew Gardens, who, in conjunction with the India Office, arranged for Mr. Wickham—(loud applause)—to go out to Brazil and collect some seeds of the *Hevea Brasiliensis*, as you are all aware. You will hear Mr. Wickham later, but I would now ask Mr. Norman Grieve to speak to this question with reference to the acknowledgment of the great service rendered by Kew Gardens.

Mr. Norman Grieve: Sir Henry Blake, Your Excellency, and gentlemen, the pleasant, but responsible task of setting before you the *raison d'etre* of the presentations which are to be made this evening has placed in my hands, and though the particular presentation which I have to deal with is that which we are offering to the Royal Botanic Gardens, Kew, it is impossible to speak to this without taking a short purview of the events which led up to the successful establishment of *Hevea Brasiliensis* in the Eastern Hemisphere. I entirely agree, sir, with the remarks of Mr. Balfour in a speech he recently made at the Albert Hall, on the value of imagination in a statesman, and I consider that it is an equally valuable possession to others in less exalted walks of life. In the history of the introduction of *Hevea Brasiliensis* into the East there is much that appeals to the imagination, and though that history is doubtless familiar to most of those present here to-night, there are, I know from personal observation, a large number of people who are under the delusion that this vast rubber industry in the East is the product of indigenous trees, whereas we know that it owes its origin, almost entirely, to the parent *Hevea* trees, the seed of which was brought from the Amazon valley by Mr. Wickham, in 1876. It would be quite out of place for me to attempt to closely allocate the credit due to particular individuals in the inception and in the carrying out of this, probably the most important transplantation of a valuable economic plant that the world has ever seen. Nor are we specially concerned to-night in recalling the names of those who in the early days urged the importance of planting rubber; were we so doing, there is one name, the name of one who unfortunately is not present here to-night, Edward Grigson, to whom all Ceylon planters would, I am sure, give a meed of praise. But, sir, it is more in regard to the procuring and establishment of the *Hevea* that we are now concerned, and in this connection suffice to mention the names of Markham, Hooker, Thiselton-Dyer, Thwaites, Trimen and Wickham. These names and those of others who laboured in the establishment and distribution of *Hevea* are graven on tablets of silver, and should, I think, be also graven on many grateful hearts. The story of how Wickham carried out the commission of the Indian Government; how he seized the opportunity of chartering the "Amazonas," a trading steamer, whose super-cargoes had, fortunately for the rubber industry, bolted with the loot, and left an angry captain an empty ship; how he collected the *Hevea* seeds in the dense Brazilian Forest and had them conveyed by natives to the steamer; how he succeeded in running the gauntlet at the port of departure for England; how the Kew authorities received those priceless but perishable seeds during the night and had them planted out, and how the youthful ancestors of a mighty forest were sent in Wardian cases to Ceylon, is indeed a romance, which without embellishment or embroidery would furnish fitting material for the pen of a Kipling or a Jules Verne. It has been felt, sir, that this is a fitting occasion, in the midst of this great Rubber Exhibition, when the men who have benefited so largely by the foresight, the perseverance and the energy of those who laid the foundation of this great industry, should offer some token of recognition and gratitude, and it gives me extreme pleasure, as their feeble mouthpiece, to ask you to present to the representative of the Royal Kew Gardens, the souvenir which we offer, as a memorial of their great achievement.

The Chairman: Sir William Thisleton-Dyer, I have great pleasure, on behalf of the various rubber interests of the Middle East, to present

the silver salver as a token of their appreciation of the good work that was done at that time by Kew Gardens, and, I can personally add, the excellent work of which I know so much in later years. (Applause.)

Mr. Wickham then came forward, amid loud applause.

The CHAIRMAN, addressing him, said: Mr. Wickham, it is also a sincere pleasure to me to present you with a certificate of the appreciation of all the gentlemen of the Middle East for the excellent work that you did in days gone by, and I have further to say, that I have authority for saying that his Excellency the Brazilian Minister, forgives you for what you did. (Applause.)

Mr. BETHUNE: Sir Henry Blake, gentlemen, after the eloquent words in which Mr. Grieve has told you of the introduction into the East of Para rubber by our honoured guest of this evening (Mr. Wickham) it would be superfluous for me to add anything. I have only to tell you that through the generosity of the rubber industry we have been able to collect a sum of £2,000. (Applause.) Of that sum a cheque for 1,000 guineas is contained in the envelope which the chairman has handed to Mr. Wickham and the rest it is proposed to devote to a modest annuity. I ought to tell you that in the main the credit of this scheme which has been brought to a successful issue to-night is due to Mr. Norman Grieve and to Mr. Crosbie Roles, the Planters' Association of Ceylon, represented by Mr. Rosling, whom, with the chairman, I am glad to see here to-night; the Planters' Association of Malay, which would have been represented by Mr. Malcolm Cumming, but that he is unfortunately unable to be present; the Ceylon Association of London, represented by Mr. Martin Leake, whose name is a household word with every Ceylon man. My part in the function has been the humble but necessary one of collecting the subscriptions, and in this I have been loyally supported by our secretary, Mr. Taylor. I think I may say that none of the rubber kings, or even the rubber barons denied our importunity. We approached them all and with very little difficulty collected this considerable sum. I will only say that the list is still open. I have no doubt every one here has subscribed—you would not be here if you had not—but in case there may be one or two little stray lambs who have not done so, I would remind you that the list is still open. I have nothing more to say, but I have great pleasure in presenting the gold medal of the Rubber Growers' Association to Mr. Wickham.

Mr. Wickham accepted the medal and bowed his acknowledgments amid loud applause.

Sir WILLIAM THISELTON-DYER: Sir Henry Blake and gentlemen, I think the Permanent Secretary of the Colonial Office, who is present with us to-night, will agree with me that this is rather a unique occasion in official history. You know that civil servants serve under the Crown, I think I may say, without fear or expectation of favour. When they do their duty they are subject to a good deal of criticism. They are very glad when their efforts meet with some success. I can honestly say, as far as I know, that the last thing they expect to get is the smallest credit for it. I find myself now in front of a stupendous piece of plate which Sir John Anderson suggests I should take away under my arm. I confess that I find the situation rather embarrassing, but I am very much comforted when I read the inscription because nothing

is more impossible than for a servant of the Crown to receive any substantial recognition of anything he has done. What Kew did in this matter was nothing more than its ordinary routine work. That institution now lives in the third century of its existence. As I have reminded my neighbour, the Consul General for Germany, it was founded in the 18th century by a Princess of his nation, who, to adopt the words of Mr. Gladstone, 'cast her aspirations into the future' of her adopted country when she founded Kew. We have done many things in the past at Kew. When I say "we," I speak of a considerable procession of predecessors in the 18th century. We—that is Kew—tried in the same way as we engaged in the rubber enterprise to transfer the bread fruit from the Pacific to the West Indies. The mutiny of the *Bounty* grew out of that attempt, and there was a chivalrous predecessor of Mr. Wickham in the Kew gardener, who stuck to the captain, and died from exposure in the boat. Peace has its victims as well as war. Well, we succeeded with regard to rubber. I can assure you that on that 14th of June, when Mr. Wickham arrived at Kew in a hansom cab with his precious bag of seeds, not even the wildest imagination could have contemplated its result in this banquet to-night. What we did was done in the most ordinary and routine way. I was the lieutenant then. My chief, who is now in his 95th year, and who has the vigour of youth, but is not allowed to dine out, would have enjoyed very much to be present here to-night; but there is one whom I miss, who was the prime mover in the enterprise—one to whom your cheer should go up—Sir Clements Markham. (Applause.) He was the prime mover also in introducing the *Cinchona* plant into India and giving India the advantage of quinine. He travelled in South America, and I think that out of quinine the idea came to him that he would round off that part of his life's work by giving to the East rubber as well. When I tell you that owing to Markham the natives of Bengal for a farthing can get 5 grains of quinine at any post office, you will realise what he did with the help of Kew in introducing the *Cinchona* tree into India. In the same humdrum way we did the same with rubber. I saw Mr. Wickham's seeds planted. We knew it was touch and go, because it was likely the seeds would not germinate. I remember well on the third day, going into the propagating house where they were planted and seeing that by good luck the seed was germinating. So rapidly did the plants grow—1,900 of them—that we had to have special cases made. On August 12th, 38 cases went out to Ceylon on a P. and O. steamer in charge of a gardener, but I will not bore you with other details. You yourselves are able to judge of the results and you can appreciate the advantage of Kew taking up a matter of this kind. The whole expense of initiation, and the whole burden of finance from first to last, was borne by the India Office, and the people to whom the Colonies in the East ought to be grateful is the Indian Government, which, I am afraid, has reaped very little advantage. You owe it that debt and it is a deep debt. I would also like to point out that Kew is not merely an isolated institution in a London suburb; it is in communication with a network of similar institutions all over the Empire, and it has the advantage of being able to command the assistance and co-operation of all of them. It may interest you to know that owing to advice that nothing of the kind would grow in the plains of Bengal, we refrained from sending these precious *Hevea* plants to Calcutta, but with the consent of the Indian Office, which was generous enough under the circumstances, we sent them to the Ceylon Botanic Garden. From Ceylon we were able to supply the Straits Settlements, and so we planted the *Hevea*

in a climate and under physical conditions which were most suited to them. But, as you know, at that time the East was not ready for them; it required imagination to see their future, but we had scientific colleagues who watched over their growth and helped the enterprise in the best possible way. I need not enumerate their names, they are perpetuated on this salver, which will pass into the custody of my successors at Kew. But I might say a word about my friend, Mr. Ridley, who has assiduously nurtured the rubber industry and fostered its expansion in the Native States. There is nothing more to add except that the thing has been a great success. Kew has attempted many things; some have failed and some have succeeded; and, as far as the officials at Kew are concerned, they feel that it is generous of you to make this presentation. I am sorry my successor is not present to-night, or he would have endorsed what I have said. We have but done our duty. Such a gift is no doubt highly irregular; but what I put to my conscience is that it is not a present to any individual—it is a present to Kew and to the nation, and it will be preserved at Kew as a public memorial. Kew has received many gifts from persons who are anxious to develop its usefulness. This, perhaps, will also answer that purpose as it will give an encouragement for the future. (Applause.)

Mr. H. A. WICKHAM, who was received with loud applause, then said: Sir Henry Blake and gentlemen, I can hardly express my sense of the honour which you are doing me this night. Such a generous mark of appreciation of a long-sustained endeavour, coming as it has, unexpectedly and in such spontaneous and kindly spirit, is doubly gratifying. Having spent most of an active life immersed in remote equatorial forest and jungle, I can make no pretence of its not being acceptable. Looking back toward the now remote sixties, I remember times of despondency, in feeling somewhat of a Jeremiah, after special visits to the old country and endeavour to induce financial people in the City of London to consider the cultivation of Para Indian rubber; it being then always received as a purely visionary proposal and not worth occupying valuable time as a business proposition. On occasions such as this it should, I think, not be forgotten how much was due to the initiative of Sir Joseph Hooker, then directing at Kew. I remember that it was he, who by exerting his great influence with the then Secretary of State for India —Lord Salisbury—obtained the issue of the Commission enabling me to get out and open the original stock. I must confess to having grossly exceeded my instructions, or rather perhaps traded on lack of instructions, but it seemed to me to be one of those occasions in which to plunge or for ever let opportunity go by the board. However, having got the stock out and the young plants coming on in their thousands in the Kew propagating houses (for me a pretty sight in June, 1876) the grave irregularity of procedure was condoned, and the bill was paid without demur by the Government of India. Sir Clements Markham, then at the India Office, and no doubt in sympathy through his having himself introduced the quinine-giving *cinchinos*, backed my representations, but owing to the depreciation of the rupee (1876) the requisition was cut. I had recommended concentration in Tenasserin and Travancore, but the young *Hevea* coming on apace and filling propagating houses at Kew, could not wait, and so were scattered to various Botanic centres in the East, a few even back to the West—fortunately Ceylon and Burma as chief depots. Sir Henry Blake, I do not know if it will be permitted but if I may, I would like to offer a suggestion.

The CHAIRMAN: Certainly.

Mr. WICKHAM: The suggestion I make is that a message of a congratulatory character should be sent to Sir Joseph Hooker, who is aged, but who still lives among us. (Applause.) Such a message would be gratifying to him.

The CHAIRMAN: I may say that that has already been included in the presentation to Sir William Thiselton-Dyer.

Mr. WICKHAM: I did not know that. In conclusion I should like to thank especially Mr. Norman Grieve and those other gentlemen who with him have in so kindly spirit taken on the burden of the initial formative committee. Also to thank Sir Henry Blake for the all too flattering terms in which he has made your wishes known.

Sir JOHN ANDERSON: Mr. Chairman, your Excellency and gentlemen,—I could wish that this toast had fallen into more capable hands. I was a little surprised that it should have been confided to me, but I presume it is not because of the office I have the honour to hold at present. I suppose a large number of you here are very much interested in a part of the world with which I was closely associated, that Middle East of which we have heard so much of and of which, so far as the rubber industry is concerned, I am sure we are destined to hear a good deal more in the not distant future. (Applause.) When seven years ago I went to the Straits Settlements, the rubber industry had but a very obscure existence. In that first year we turned out about 50 tons of rubber. and not all that by means plantation rubber, because though we have heard excellent testimony borne to the work of Mr. Wickham and Kew Gardens, a great deal of the rubber which the Middle East was turning out at that time was undoubtedly indigenous rubber, because the *Hevea* was still in the position of being an experiment. It is a long jump from 50 tons a year to 10,000 tons, which we hope to present to the markets of the world in the present year. If we make a similar advance in the next seven years the position will be still more satisfactory. All the splendid results shown at the Exhibition have been due to very hard work on the part of those concerned in the industry; not only those engaged in the production of plantation rubber, but also those engaged in the collection of native rubber—indigenous rubber. Brazil still supplies the world with a great deal more than half the rubber which is produced, and I think it is one of the most remarkable things—and no doubt due to the fact that Brazil is becoming fully alive to the serious competition of plantation rubber—that we are told that the authorities of Brazil are taking active steps towards giving facilities for the collection of rubber, in paying greater attention to its collection and preparation, and fostering it in every way. I am sure that those most interested, as you all are in plantation rubber will not hesitate to welcome that, because, after all, in an industry like this, it is competition which brings out the best qualities of those engaged in the industry, which brings them up to the mark, keeps them to the collar all the time, and ensures that they will give to the industry the best that is in them. It has been suggested that in a very few years the price of rubber will have fallen to such a point that the indigenous rubber will cease to be marketable; but I think those who suggest that forget our friends who are considerably represented here to-night—and I am sure we all welcome them—I allude to the manufacturers. (Hear, hear.) It is extraordinary when one comes to think of the enormous number of uses to which rubber is put. We find it not only in our own homes at every turn, but we find it on the way

from our home to our business, we see rubber at every stage, and when we get to our business we find it in our offices. Certainly we cannot live without rubber, and I am not sure we are able to die without the assistance of rubber. To all these possibilities of extending the uses of rubber, which are practicably illimitable, our friends the manufacturers are keenly alive, and it is occasions like this that have an enormous advantage in bringing together those who are concerned, manufacturers and producers, because the grower of plantation rubber naturally wants to meet the wants of his customers and to do that he wants to become acquainted with them. The meetings and discussions that are taking place, and the personal meetings between manufacturers and producers, cannot help but give a great stimulus to the work. It guides producers in what they have to do, and what they have to look for in preparing their produce for the market. We have not only these parties interested in the rubber industry, but the whole world is interested in it. It is an industry which in all its stages calls for the use not only of keen intelligence and hard work, but it calls for the best scientific knowledge; and those who are engaged in the production of plantation rubber are most keenly alive to all these points, and especially to the necessity of utilising the best results of scientific knowledge in regard to the industry in which they are engaged. That is one of the circumstances which offers, I think, the very best possible guarantee for the future which lies before plantation rubber, and I am sure that so long as we have men concerned in the industry like those I see around me to-night, men who fully realise the importance of utilising the scientific knowledge not only of the chemist but also of the entomologist, the mycologist, and those who make a special study not only of the growth, but of the diseases of rubber—I say so long as the planters continue to use, as they are now doing, the results of the labour of these scientists, the future of plantation rubber is absolutely assured. (Applause.) Gentlemen, I will not detain you longer, because I know you all desire to indulge in more pleasant occupations than listening to speeches. Last year, on the occasion of the opening of an agricultural show in my capital of Singapore, I made a statement which I know gave rise to some criticism, as to the extent to which in a few years plantation rubber will be produced in the Middle East. Well, gentlemen, I made that statement, after having sent round to my officers who are concerned in the matter to collect the figures most carefully. My figures have been questioned and my statement that in six or seven years the Malay Peninsula would be producing as much rubber as practically the whole of the world produces at present has been challenged. I therefore went over my figures and made further enquiries from those whom I considered best able to inform me in the matter, and I have no hesitation in repeating the statement I then made, that undoubtedly, unless our friends the manufacturers on whom we rely to find extended uses for rubber, do so, the price of rubber will undoubtedly fall, and then the question whether indigenous rubber or plantation rubber is to have the market to themselves, will be settled one way or another. As I said, I will not detain you longer. The toast is one which is practically "Our noble selves," and therefore appeals to all of you. I will couple with the toast the name of Mr. Edward Rosling (applause) who will reply for rubber production, and Mr. Pegler and Mr. Spannagel, who will reply for the rubber manufacturers. I give you the toast of "Prosperity to the Rubber Industry."

Mr. Ed. Rosling, who was received with cheers: Sir Henry Blake, your Excellency, and gentlemen,—I greatly appreciate the honour done

me by being asked to reply to this toast to-night; but at the same time I feel very great difficulty in dealing with the subject. As you are aware, like Gaul, rubber is divided into three parts, plantation rubber, crude rubber, and synthetic rubber. (Laughter and applause.) As a planter, I do not know much about plantation rubber, I know less about crude rubber, and I know nothing at all about synthetic rubber. (Applause.) It will save time if I say what I am not going to tell you. I am not going to tell you that plantation rubber is not a gamble, I am not going to tell you that plantation rubber is one of the soundest investments, I am not going to tell you that in a few years' time the plantations will be sending home a quality of rubber never excelled in the London market; I am not going to tell you this, because those interested in plantation rubber know it for themselves. (Hear, hear.) A few nights ago I heard an after-dinner speech defined as one slightly humourous, but totally irrelevant to the subject under consideration. I know my own limitations. From my earliest days I have always been warned I should not try to be funny, and as regards the other point I asked the secretary if I might talk about anything else, but I was told I must confine myself solely to rubber. Gentlemen, for the last fortnight we have thought of very little else, we have slept rubber, we have dreamt rubber, and I believe sometimes at lunch we have eaten rubber, and I am sure our digestions—both mental and physical digestions—have run a great risk of suffering from that diet. (Laughter and applause.) But at the same time one has to talk about something. To-night I had hoped to have had some diagrams prepared, diagrams somewhat similar to those you see in the Malay section, telling you how plantation rubber is going on and the number of tons we are going to send, the number of coolies we are going to use, and the number married and otherwise, but I fear that if those diagrams were placed before the company they would have a bad effect on the labour market for the world. But, gentlemen, to treat the subject somewhat more seriously, in the days when every schoolboy is taught to think and talk imperially, plantation rubber is not going to play an unimportant part in the binding and strengthening of the empire, and increasing the wealth of the Mother Country. But, gentlemen, if this is a great feature, there is still a greater feature. We welcome here to-night the representatives of the great producing colonies, and we have it from Sir John Anderson that the present colonies will become plantation producing colonies, and in this we have a common interest, which will bind us all together and will be one of the factors making for universal peace, while forming a basis of scientific and commercial advantage. On behalf of the producers of rubber, both plantation and otherwise, I beg to thank you for so kindly proposing this toast. (Applause.)

Mr. PEGLER (Northern Rubber Co.): Sir Henry Blake and gentlemen,—I feel it is not for me to detain you at any length at this late hour. Rising amongst you who are mostly interested in plantation rubber, I feel I am in a very humble capacity in being only a manufacturer. I feel I am only one of the poor men of the earth, and that the whole of you are wallowing in wealth. One gentleman spoke of the advantage of imagination. I recognise the advantage of imagination as having borne fruit in the magnificent results which we are celebrating, and which has been brought about by perseverance and industry. The success of the rubber industry has been beyond what my imagination led me to expect, and I regret this want of imagination on the part of myself and other manufacturers in believing in the inflation of the past year. That inflation was a bad thing for the industry. It is bad for an industry when its

prime factor is subject to too vast and too wide fluctuations; it does much harm. When the raw material advances too much in price, it leaves the manufacturer to all sorts of adventitious aids. If you cheapen your production too much you reduce your quality, and if you reduce the quality you do injury to your trade. When I was chairman of the India-rubber Manufacturers' Association of Great Britain I was called as witness at the Tariff Commission of Mr. Chamberlain, and a gentleman asked me, "Is there not a great deal of adulteration in your trade?" I said, "We do not call it adulteration; we call it the science of manufacture." (Laughter.) You take it as a joke, but it is not a joke; because there is a great deal in the science of manufacture. It is not pure rubber which will give you the best results in everything. You want intelligent adulteration and intelligent treatment of the rubber to get the best results, and I say without fear of contradiction that the man who can by treating his rubber, improve it for any purpose, or make an equally good thing for less money, is conferring an advantage on the community. But, on the other hand, if you make the stuff too cheap and make it bad for its work you are a traitor to your trade and an injury to your country. (Hear, hear.) Speaking as a manufacturer, I would ask what the industry would be without the manufacturer. In the past year there have been advancing prices, and some people have gained while others have lost. We have had much trouble with all our customers, and I can only say that if in the future we have moderate prices we shall be able to produce articles which will recapture the trade we have lost and will enable us to open up further fields. (Applause.) There is no limit to the uses of rubber, because as you cheapen it you increase its use. (Applause.)

Mr. Spannagel (United Berlin Frankfort Rubber Co.): I have to apologise for having to address you in a language which is not my own, but which is the Shakespearean language. You will notice the difference, but I hope you will forgive me, and I shall not offend your ears for a long time. A stranger and a business man coming to England for the first time soon finds out that London is the centre of the commercial world, and it is an unrivalled position which England holds in the world to-day. There is a spirit of enterprise, an energy and an amount of intelligence everywhere, and these qualities have been applied to the rubber industry. To me the object of the highest interest in England has been the Englishman. I will not abuse your patience by entering into any remarks upon the English character, but, with your kind permission, I will take the liberty of giving you a few of my personal impressions. I have realised that "Britons never shall be slaves," and true words they are—words that are realised by the other countries of the world. In the days gone by, perhaps too little attention has been paid by Englishmen to their Sovereign, but this cannot be said to be the case in the Coronation festivities which have been taking place. One point that has been impressed very strongly upon me is that the Englishman must be studied in his own home—in his family life—for it is there he shows his best qualities. I have seen a good deal of English family life and I have a great respect for it. I have been immensely struck by the great respect the English gentleman pays to his wife and the respect English children have for their fathers—surely a great sign of good education and high moral standing. There is much charm and much gentlemanliness in English family life which creates a warm feeling of friendship, and if once you have acquired the friendship of an Englishman, you are sure to find him a trustworthy friend. I speak from an experience of years.

But there is one virtue which is a specific virtue in England—at least I have found it so—and that is discipline and common sense. Wherever you are, in all parts of the globe, you will find it a common experience that the Englishman brings common sense to bear on everything in modern life. There is a country larger than England, larger than Germany, larger than France, larger than Russia, larger than America, to which our best activities and noblest aspirations should be devoted, and that is the country of mankind, and in the cultivation of that country one wants lofty ideals and good ideals and a warm heart. With these qualities this century will not go down to posterity as the century of Dreadnoughts, but as a century which had the glorious motto of "Peace on earth and goodwill to men." In the words of Prof. Forster, I have formed an invincible belief that the nations will come to an understanding not to destroy but to build up, and do their best for suffering mankind. There is every prospect of a bright and hopeful future. You all know the words of Longfellow :—

> "Lives of great men all remind us
> We can make our lives sublime,
> And departing leave behind us
> Footprints on the sands of time."

And here let me remind you that England is the country which has given to the world some of its greatest geniuses, and the greatest helpers to the cause of civilisation. Amongst the philosophers names like Young, Bacon, Sir Herbert Spencer ; amongst historians Lord Macaulay, Gibbon, Carlyle ; among poets Shakespeare ; amongst novelists, Dickens and Thackeray ; amongst politicians Gladstone ; amongst scientists, Sir Isaac Newton and Charles Darwin. England has always been celebrated for bold inventors, such as Watts and Stephens, whose inventions have changed the world. In the rubber industry you have Dunlop, the inventor of the tyre who formed a new branch of our industry. In medicine you have the name of Jenner ; in travel you have Livingstone and Sir Henry Stanley, and later still you have Shackleton, and I might mention many others. In politics you have Lord Wellington and Sir Robert Peel ; in naval warfare you have Lord Nelson, the great national hero ; and in philanthropy among many others you have the name of Carnegie and the name of Miss Florence Nightingale, who did so much to lessen the suffering of mankind. I will not say more, but ask you to raise your glasses and join me in drinking to England, the country of common sense and self-discipline, and also to those whom I would not allude to without profound respect, the English ladies.

Mr. J. L. Loudoun-Shand : Sir Henry Blake, your Excellency and gentlemen, At this late hour I have had several broad hints that brevity is the best quality of any further speeches. The toast entrusted to me is that of the "International Rubber and Allied Trades' Exhibition." When I was first asked to propose this toast, which I do with very great pleasure, I tried to evade it, because I am one of a past generation, and I thought it would be much more ably done by some one of those who are deeply interested in the progress of rubber cultivation in the East ; but I got a letter from Sir Henry Blake saying that it was his wish and that of the committee that I should do it, and it would have been churlish for me to refuse to do it when Sir Henry Blake has done so much for this exhibition. I looked upon it as a mandate, and I am pleased to be here to-night to propose the toast. The task is rendered all the more easy because I think we are all agreed that this exhibition

has been a great success. Whatever might be the shortcomings of the speaker in proposing the toast, you will all agree that the Exhibition has been successful, and the toast will, therefore, be enthusiastically received. Planters and producers have come forward from the East and from the West, and have shown the very best they can produce; and I am sure it will be to our mutual advantage. Our friends, the mechanical engineers, to whom we owe so much for what they have done in the perfection of machinery and rubber appliances, have come forward also, and I am sure we owe to them a very deep debt of gratitude. It may be they may go away a little bit disappointed and say, "We have not done as well as we might," but they may remember this is in the seed time and that the harvest we hope for will come afterwards. (Applause.) We have also been much interested in seeing the many possibilities for rubber. I have been pleased to hear from my friend on my right that they can use up all the rubber we can produce. You have only to look round the exhibition and see the mechanical and scientific appliances for which rubber is used to realise what the great possibilities are. I was very much struck on reading a letter by Mr. Wright, which formed a part of the catalogue of this exhibition, in which he said that in 1827 30 tons of rubber were all that were in sight, and in 1910 we had 76,000 tons of rubber. I question very much if the world has ever seen any enterprise which has extended to such an extent; and when we see the size to which it has been built up, it seems wonderful to believe how the world got on without it for so long. I think the inflation referred to has done harm, but it will right itself. Mention was made by a gentleman in the room of Sir Ernest Shackleton, and it has always surprised me that he has not discovered forests of caoutchouc on the edge of the seas surrounding the poles. In that case no questions would have arisen about area or validity of title. (Laughter.) To be serious, it seems to me an exhibition of this sort cannot but do a great deal of good. The mechanical engineers are prominent here. We, planters and producers, are their customers, and come in contact with them. The manufacturers are our customers, and they have now learned that there need be no fear of their not having abundance of rubber for all future purposes. I think the harmony created by producers, manufacturers and mechanical engineers coming together does an immense deal of good, and I think we shall all look back to this exhibition with very great pleasure. Let us look for a moment at what are the reasons for the success of this exhibition. We have, first of all, to look to our President, and I feel, and know you all feel, that the success of this exhibition is in a great measure due to Sir Henry Blake. I know perfectly well he will get up and disclaim this, and he will say the officials did it. That is not so. If you have an active head you will find all the others work efficiently and energetically, and if you have an inert head everything goes the other way. We therefore feel thankful we had Sir Henry Blake in the position which he has filled. He has held many of the most important offices under the Crown which are in the reach of anyone, and he has filled them right well. I am sure it is a great satisfaction to us to feel that in the time of his retirement he is not devoting himself to a life of ease and becoming an imperial encumbrance, but by the zeal and energy which he has thrown into this exhibition he has become of great imperial assistance. I am sure we can look back upon this exhibition with great pleasure. We shall soon have another, and I hope he will be President again. I give you the toast of the "International Rubber and Allied Trades' Exhibition," coupled with the name of Sir Henry Blake.

The toast was drank with much enthusiasm.

Sir Henry Blake: Gentlemen, I am grateful to Mr. J. L. Loudoun-Shand for the way in which he has coupled my name with this toast. The exhibition is a good one, but, gentlemen, the first duty that I feel it necessary for me to perform is, as gracefully as possible to take from my brow the olive wreath Mr. Loudoun Shand has so kindly placed upon it, and to place that olive wreath on the brow where it ought to rest. It was very kind of Mr. Loudoun-Shand to say it was my initiative, or my work which brought this exhibition to a successful issue. It was not. The man who brought this exhibition about, and brought it, by his indomit, able energy, to the successful conclusion it has come to, is Mr. A. Staines Manders. (Applause.) He has worked at this exhibition with the most extraordinary energy and perseverance. He has travelled in foreign countries and has left no stone unturned; he has bothered me out of my life. (Laughter.) Gentlemen, as I say, the exhibition is unquestionably a good one. I went round a short time ago to get tips from the judges if possible. I found one gentleman looking at crepe rubber, and he said it was good. I asked him "Why?" He said, "It is hard and gritty and it is the proper stuff; this is what we want." Then I went a short distance to another court, where we see most beautiful and smooth rubber, and they said, "This is what we want for the manufacturer." It is very difficult to settle what rubber we require. We have blocks and sheets, and biscuits and crepes, smoked and light, and rubber in every form, but we have not one thing which I think is necessary to secure in the future, and that is, if possible, a standard rubber of from one, two or three standard crops, so that manufacturers may come and buy the rubber and know before he gets his purchase what he is going to have. Then, in my opinion, the manufacturer will be in a position—I speak subject to correction—to know exactly what he will have to deal with. The only way in which this can be brought about is by the rubber growers in certain countries settling the points themselves. They must decide what the standard of rubber is to be, and then operate with their latex in the production of that rubber, possibly by mixing the latex. Now there was a very interesting incident the day before yesterday, when rubber from two districts was vulcanised. That rubber was, apparently, the same, and presented that quality of resilience that is necessary. When they were equally tested it was found that one rubber from a certain country was very much superior to the other after going through one vulcanising process, but there was nothing to show the reason of that. To my mind that is what we want to know, and we must look for those reasons. We want to find out by analysis whether that rubber was affected by climate, by soil, by the age of the trees, by the rapidity with which the latex was taken out, and other matters. All these questions have to be solved, and these, to my mind, are the practical questions with which we have to deal in an exhibition of this kind. Now, gentlemen, I will not detain you any longer. I will only say that personally I thank Mr. Loudoun-Shand for the way in which he proposed the toast, and I thank you heartily for the way in which you received it; and I would ask Mr. Manders, to whom we owe so much, to say a few words upon it, because he knows more about this exhibition than any other living man. (Applause.) I was astonished in reading some long notices of this exhibition in the *Times*, that I did not find his name mentioned, and I hope that in the future, whenever the exhibition is mentioned, that the credit of it will be placed upon the proper shoulders, and that is upon the shoulders of Mr. A. Staines Manders. (Hear, hear.)

Mr. A. Staines Manders, who was received with applause, said: Mr. Chairman, your Excellency and gentlemen, I thank you for the very kind way you have received Sir Henry Blake's remarks in reference to myself and the exhibition. Certainly I have worked very hard to bring it to a success, a success which most of you gentlemen have admitted, and Sir Henry has very kindly placed all the credit upon my shoulders. Two days after the last exhibition closed I started to organise the present one. For these three years Sir Henry Blake has given me his kind advice and assistance in every possible way, and it is with his help that the exhibition has achieved such success. But what would it be without the exhibitors? It has exhibitors from all the countries of the world; gentlemen whom I have met in their own countries and others whom I have met here; gentlemen who have given me their advice by letter from different parts of the world, and have helped me to bring the exhibition to a satisfactory issue. Without their support we could have had no exhibition. Further, I should like to state that there were two working constantly in connection with the exhibition, and the other was my niece, Miss Fulton. (Applause.) I think very many of the gentlemen present have met her during the exhibition. She has worked in the same way as I have, and the two of us have organised and brought this exhibition about with the kind assistance of gentlemen from all parts of the world. I thank them sincerely for the kind support they have given me, and the way they have met me on every occasion. It is very difficult for me to respond to a toast of this sort. I may be a worker as far as exhibition organisation is concerned, but I am a very poor speaker. Again, I assure you I sincerely thank you, and I thank you again, Sir Henry Blake, for the kind words you have used in giving the credit of this exhibition to me. In conclusion, I wish, with your permission, to propose a toast. That is the health of those who have very kindly assisted me in making the exhibition known all over the world, my friends the members of the Press. During the last three years the Press have been very kind. They have sent information relating to this exhibition to all parts of the world, and I must admit they have given me credit—a credit very often I did not deserve. And they have also given credit to others—Sir Henry Blake and Miss Fulton—and I thank them. With your permission I wish to propose the toast of the Press, coupled with the name of Mr. Herbert Wright, editor of the *India-Rubber Journal*, and Mr. Stevens, the representative of the London Press.

Mr. Herbert Wright: Sir Henry Blake and gentlemen, I notice that not one of the previous speakers has apologised for the position he has been placed in this evening. I was never any great man at after dinner speeches. As planters in the East know, I never cracked a joke in my life, and I must put the blame for the suffering I am inflicting upon you upon the broad and willing shoulders of Sir Henry Blake. I recall the time when, as far back as 1905, I was appointed editor of the *Tropical Agriculturalist in Colombo*, and in the following year Sir Henry organised the exhibition and again and again I saw him. Therefore, I am right in putting the sufferings I am inflicting upon you on his shoulders. Then I find I am placed at table No. 13. (Laughter.) However, I thank you very much for the way you have received the toast. I want on behalf of the Technical Press of the United Kingdom to offer, not the usual formal greetings, but a hearty, warm welcome to the representatives of the Technical Press of Belgium, France, Germany,

and New York, and even from the East. I doubt whether every member here fully appreciates the fact that in this audience we have practically the finest collection of technical press representatives that have ever foregathered in the history of rubber. I hardly like making suggestions, but we are all aware of the appointment of His Royal Highness the Duke of Connaught as Governor-General of Canada this year, and of the prospect of a still higher honour being paid to the Dominion. It occurs to me it might be well if our American friend, in celebrating that visit, would hold a Rubber Exhibition. In conclusion, I am informed by many representatives of the Technical Press that they are more than satisfied with the reception accorded to them. That means a very great deal. It means, on the one hand, there is great satisfaction, and I am sure, on the other, it means that there must have been great suffering. I think the Technical Press should express their gratitude for the assistance they have received from the official guide, a most magnificent production, entailing a great amount of work, and which has been compiled almost entirely by Miss Fulton. (Applause.) I also wish to thank the official representatives of the various countries for the way in which they have furnished information. This has been of great help, and the information given us will stand as a permanent record on matters appertaining to rubber. On Monday last a gentleman know probably to 70 per cent. or 80 per cent. of those in this room came to my office. He was annoyed and stated that the rubber exhibition and all contributions to the Press were doing serious harm, and as a man dealing with the raw product he was not inclined to favour publicity in any sense regarding the future of plantations. Well, gentlemen, I can only say that he might as easily try to stop the tide as try to stop publicity with regard to plantations. I believe the wide publicity hitherto given to the work of plantations, and the work of the Middle East, has had a very high educational value in the general literature of to-day, and it is not our intention to in any way forego our rights in any matters which concern the future of commerce. Perhaps many of you do not remember—I am sure Sir Thisleton Dyer will remember — that so far back as 1874, Hancock, whose name has been associated with vulcanisation for 70 years, seeing a demand for rubber coming, suggested in the *Gardiners' Chronicle* that plantations should be established. That has been followed since by every representative of the Press, and I believe that considerable benefit has accrued therefrom. Lastly, I wish to make a few remarks with regard to our indebtedness also to the Middle East and Africa. There is in this room a very fair number of planters who represent the industry in Java, Sumatra, Borneo, F.M.S., and South India. We have Talbot, Rosling, Fraser, Grieve, Windle, Richardson Rutherford, beside many others. I must also mention our old friend Mr. Wickham. These planters have for many years, and especially in the last six years, been working under conditions which very few of us can imagine in this country, and it is to their perseverance and their energy that the future of the whole industry undoubtedly depends. They have accomplished what will in a short time revolutionise the modern methods of business in association with this product. I therefore think we are more than ordinarily indebted to them. I thank you very much for having proposed the toast. (Applause.)

Mr. Stevens: On behalf of the Press I thank you for your entertainment and congratulate you on the results of the exhibition. We all look forward to the time when we shall all have rubber roads, and so forth.

The Chairman: That concludes the toast list, but it has been

suggested to me that perhaps you might like to hear a few observations from Mr. Kelway Bamber. His observations are always illuminating, and with your permission I would ask him to say a few words on the chemical and planting aspect, as so many of us are assembled here together. (Applause.)

Mr. Kelway Bamber: It is rather a surprise to me to be called upon to make any remarks at this late hour. I have been asked to say something about the co-operation of planters and the present position of the rubber industry in the East, and I will make them very brief. I know little about co-operation, and I may say, from my knowledge of planters, how difficult it is to get them to co-operate and give one kind of rubber. Everyone has a tendency to try his own method and to produce the best results he can, and it is difficult to get any uniform system. From what I have learned of this question, I also find the manufacturers are not prepared to say any one form of rubber is required. While one manufacturer requires one form, another prefers something else. We can only urge the planters in the East to do their utmost to produce a rubber that is uniform, so that the manufacturer may know that when he has bought a certain mark he can always rely on rubber bearing that mark being the same, so that in his vulcanisation tests and experiments he may know that his products will always be of the same uniform quality. The statement has been made that marks are obliterated. I have been talking to some of the leading manufacturers, and they have advised that as far as possible planters should invariably mark every sheet of their rubber in some standard way, so that it can always be recognised. I have been asked to make a few remarks about another point, and that is the present price of rubber. In all our estimates for production of rubber in the East I have never exceeded a price of 3s. per lb., which will always give us a very remunerative return. We have been receiving prices out of all proportion to the cost of production, and no doubt these prices have done much to injure the industry. With a fairly fixed ratio of prices I think there is not the slightest doubt that the rubber industry is a perfectly safe one. No doubt there are many who have purchased shares at the highest price and have felt the present fall in prices, but I should like to assure the holders of rubber shares that even at 2s. 6d. per lb., or 2s. per lb. rubber will be a very paying industry, so that there is no need for anxiety or to sell their shares in the fear that rubber is going to be an unprofitable investment. (Applause.)

The Chairman: There is one subject which struck me, and which I did not mention. It is that it would be a very valuable thing—and I know it is in the minds of a great many people here, especially from Ceylon and the Malay Peninsular—if it were possible to so arrange that a testing machine would be within their reach by which their rubber could be easily tested. How that is to be secured is a question of detail, but I may say that anything put forward by the colony to my friend on my left, Sir John Anderson, would receive his sympathetic consideration, for I know how strongly he feels and how strongly he is interested in the rubber industry in general.

Mr. Manders: Before we separate I wish to propose a vote of thanks to Sir Henry Blake for occupying the chair this evening.

The health of the President was drank with great enthusiasm.

Sir Henry Blake: Thank you, gentlemen.

The proceedings then terminated.

Tuesday, July 11th.

A large number of representatives of the Press and exhibitors entertained Mr. A. Staines Manders and Miss D. Fulton at dinner at the Holborn, and during the evening Mr. E. G. Salmon, editor of the *Rubber World*, on behalf of those assembled, presented Miss D. Fulton with a gold watch as a token of the regard and respect in which she is held by those taking part in the Exhibition.

Wednesday, July 12th.

Gentlemen connected with the Dutch section of the Rubber Exhibition dined together at the Hotel Metropole last night, the company including: Mr. H. S. J. Maas (Consul-General for the Netherlands, and President of the Dutch Royal Commission for the Exhibition), in the chair; Lieut.-General J. B. Van Hentsz (ex-Governor Dutch East Indies), Mr. K. Van Bannekom (Hon. Consul for Belgium), Mr. C. H. Moens, Dr. A. H. Berkhout, Mr. Slingervoet Ramondt, Dr. Van Rouburgh, Mr. H. A. Wickham, Mr. Staines Manders, Mr. A. G. Swart, Mr. Jac Musly, Dr. Tromp de Haas, Mr. J. G. Von Hemert, Mr. Pollet (Consul-General for Belgium), Mr. F. C. Stoop (President Dutch Chamber of Commerce), Lieut.-Colonel Prain, and Messrs. Bingley, E. Rosling, Richardson, and Hammond. The Chairman, having given the toasts of the rulers of this country and the Netherlands, proposed " Success to the Exhibition," and heartily thanked Mr. Manders, Mr. Swart, Dr. Tromp de Haas, and others who had done so much to make the Netherlands section such a great success. Mr. Swart, who spoke of rubber cultivation as an important bond between nations, went on to pay a tribute to Mr. H. A. Wickham, through whose efforts the seeds of the *Hevea* were obtained from Brazil, and the rubber industry established in the Middle East. Speaking for British capital involved, Mr. Hammond referred to the difficulties of land tenure in Java, and on behalf of foreign investors expressed their willingness to accept the Dutch view of the question as expressed by the Dutch Government and interpreted by Dutch judges.—*Daily Telegraph*, July 13th.

Mr. J. A. Richardson, Commissioner, and Committee for Southern India, entertained a large number of friends.

Thursday, July 13th.

His Excellency Dr. von Lindequist, German Colonial Minister, accompanied by Dr. Busse, German Imperial Colonial Office, visited the Rubber Exhibition. They were met by Dr. H. Johannes, Consul-General for Germany, and Mr. Staines Manders, the manager of the Exhibition.

Distribution of Awards.

FRIDAY, JULY 14TH.

The closing ceremony in connection with the Exhibition was the distribution of the awards, which took place in the centre of the large hall, where the opening ceremony had been performed. Here a small platform was erected and Sir Henry A. Blake was surrounded by a representative company. On taking the chair:

Sir HENRY BLAKE said :—It is now my pleasant duty to hand over numerous medals, certificates and trophies that have been offered by generous donors for special competitions. It gives me great pleasure to distribute them to those to whom the judges have awarded them.*

The handing over of the various prizes concludes not alone my duty to-day but concludes the very pleasant duty of acting in the honorary position of President of this Exhibition. I think we may all say, ladies and gentlemen, that the Exhibition has been well done. (Applause.) It consists of two parts. It consists of the portion which people come to see, of which you can judge as you look round, but it also consists of the portion which the people come to hear, of which the general public have not been aware. In the committee room from day to day everything connected with the processes of rubber from the planting and the growing to the preparation and the manufacture has been dealt with by able papers, written by men who have come from every part of the world. To them now on behalf of the committee and on behalf of the Exhibition I beg to tender my warmest thanks. From time to time I have been complimented upon the Exhibition and the manner in which it has been carried out, but I am bound to say that I receive these compliments somewhat in the same frame of mind as an elderly lady who has been complimented on her complexion, which was not her own. (Laughter and applause.) I have posed as the President of the Exhibition, and, although I cannot say it was a merely ornamental office, or that I was an ornamental President, yet as far as I am concerned with the Exhibition I had to take no more thought than the lilies of the field. The Exhibition was conceived, worked, carried out from beginning to end by Mr. Manders, the general manager, to whom I now offer my grateful thanks for the way in which everything has been done. (Applause.) This is the third Exhibition of which I have had the honour to be invited to be President, and, looking back now over the period of six years I myself can see how solid an advance has been made in the great industry in which we are all interested. I think that those of our old friends who were here three years ago at Olympia have recognised that fully. And, further, while it is difficult to lay one's hand upon a particular point and say, "This is better," and "That is better," there is a general feeling that there is an advance all round and that we have learnt certain things at this Exhibition that must be the basis for grave thought and for possible improvement and great economy in the future of the production of rubber. Happily, here we have had together for the first time the manufacturer who has been meeting the producer, and, as I said on another occasion, probably what we look forward to in the future is a standardisation of the production of rubber. Every manufacturer knows the importance of that. Outside these matters, which I will not detain you by speaking on now, there is the fact that we have come together here for three weeks, many old friends meeting each other in

(* NOTE.—The list of the Awards will be found under a separate heading.)

friendly competition, happy once more to grasp each other's hand and to talk over that which interests us all. That which brings countries together, and that which strengthens the bonds between man and man in a great commercial undertaking, that is really the basis of universal peace. We have from thirty-three different Governments in the world received delegates and exhibits, and there is no better or more solid conference for the peaceful progress of the world in the future than a meeting such as this. We have also welcomed new friends who were not at the last Exhibition, but have now come and exhibited their products. We have welcomed here what we saw in embryo on the last occasion. The West Indies have come to show us that they too intend to take a hand in the future, and, looking into the next court, King George's Hall, where I hope many of you have gone to see the interesting exhibits, there we have got all those countries—so to speak, the children of the industry—who have come forward and shown us what they have produced up to the present. They have not spoken much for themselves, but I think if you look, as most of you have, at that interesting exhibit from Uganda, you will find that, if necessary, they could use a pretty big term with great effect. I do not know that there is anything more to say than that now it becomes my duty—a pleasant duty at the end of a successful Exhibition, and yet a painful one because it means the separation of friends who have learned to know and to appreciate each other—to declare, as this Exhibition is about to close, how fully and how gratefully the committee acknowledge the way in which their enquiries have been responded to by the different countries, and to wish you, ladies and gentlemen, with every pulse in my heart, every happiness and prosperity individually to yourselves and collectively, for the various countries you represent. (Applause.)

Mr. A. BETHUNE: Before we separate I should like to ask you to pass a very hearty vote of thanks to Sir Henry Blake; not only for the very graceful way in which he has presided to-day, but also for all the work he has done in connection with this exhibition. We have come to associate his name with successful Rubber Exhibitions, and I hope that, if there is another one two or three years hence, he will again grace it by taking the position of President. Speaking for the Rubber Growers' Association, I should like to say how we appreciate the large number of entries for our prizes, and we feel sure the investigations which have been made will tend to help us to arrive at what we want to know—the best way to prepare our rubber in order to suit the manufacturers.

Sir HENRY BLAKE: Ladies and gentlemen, I thank you very much for the kindly way in which you have responded to this vote of thanks. The *esprit d'escalier* is well known. One thinks when he goes out of the room how much better he might have said something he has said; and there is something I wish to say. That is, that we owe so much of the success of this Exhibition to Mr. Manders, and, as some things have been bracketted here to-day, we might, in the adjustment of our grateful thanks, bracket with Mr. Manders the most excellent secretary we have ever known, in the shape of his niece, Miss Fulton. (Applause.) I not only offer her now my own personal thanks, but I am sure that on your behalf also you will agree cordially with me in an expression of gratification at the way in which Miss Fulton has done her duty. ("Hear, hear.")

The proceedings then terminated.

Sir Henry A. Blake, G.C.M.G., presented Mr. A. Staines Manders with a diamond and sapphire pin, and Miss D. Fulton with a diamond and moonstone brooch.

Presentation of the "India-Rubber Journal" (London) Shield, and "Grenier's Rubber News" (F.M.S.) Silver Trophy.

THURSDAY, SEPTEMBER 14TH.

The presentation of these trophies was made at the London Chamber of Commerce on Thursday, September 14th, by Sir Henry A. Blake, G.C.M.G., a large number of gentlemen interested in the rubber industry being present, amongst whom were :—Sir J. A. Swettenham, Monsieur E. Pollet (Consul-General for Belgium), Messrs. H. Kerr Rutherford, R. K. Magor (Chairman, Rubber Growers' Association), A. S. Morrison, E. F. Woods, Herbert Wright (*India-Rubber Journal*), H. A. Wickham, W. T. Gibson, H. Hamel Smith (*Tropical Life*), S. C. Mote, Gordon Dickson (Sungei Kapar Rubber Co., Ltd.), G. G. Anderson, E. G. Salmon, Gerald Fitz-Gibbon, J. Burrows, A. Crabbe, W. A. de B. Maclaren, Dr. Schidrowitz, W. G. Millen, C. Taylor, A. Staines Manders (Organising Manager of the Exhibition), and Miss D. Fulton (Secretary).

Sir HENRY BLAKE said: We are assembled here this morning for the last act in connection with the Rubber Exhibition, upon the success of which we may all congratulate ourselves. It is for the purpose of presenting the trophy given by the generosity of the proprietors of *The India-Rubber Journal*, and also one given by the proprietors of *Grenier's Rubber News*, for the best Para rubber. I congratulate the company that has won both these prizes. I may tell you both competitions were separately judged, and the judges were in each case independent and knew nothing of the others. The specimens laid before them from the various companies were only indicated by numbers, which had no connection with the numbers in the Exhibition catalogue, and I think it is a most remarkable fact and one that reflects credit upon the judges who so kindly gave their attention to this matter, that both of these sets of judges having considered separately the various exhibits sent in, have decided that the Sungei Kapar Company's was the best specimen. Not only had they decided this, but in deciding the number of marks awarded to the various companies, they awarded the Sungei Kapar Company 98½ per cent. in one Competition, and 96·5 in the other. That shows, gentlemen, that in judging rubber it is clear there is a certain standard, and that the judges understand clearly what that standard is. They must have most carefully considered all the various points before coming to a decision, and the verification of the decision of one set of judges by the decision of another set of judges quite independent, is very satisfactory to everybody concerned. I congratulate the Sungei Kapar Company most heartily upon their success.

I find on looking at the list that there were other companies in the running for *The India-Rubber Journal* Shield—that magnificent shield we see there, and which I am afraid the representative of the Sungei Kapar Company will hardly be able to take away with him this morning. The Sirinwasa, an estate in Kelani Valley, Ceylon, belonging to Mr. da Silva, secured 94 marks, Tremelbye and Bukit Rajah 93·5, Highlands 92·5, Culloden 92, and Klanang 90. All these companies are very highly commended for their exhibits, and I congratulate them also on having attained that position in a competition which covered the whole of the rubber-growing countries of the world practically. I do not think I have any more to say on this occasion. I think we all understand clearly—you gentlemen interested in rubber understand—that the last word has not yet been said upon growing or preparing for the market. There is a great deal still to be done in both directions. We don't know whether the latex from rubber trees will continue for any length of time or for how long, or whether it decreases, or whether there must be a change or increase in the manuring in the future. I can only say once more that I congratulate the Sungei Kapar Company on their success, and hope that the other companies mentioned, which have come so very near perfection in this Exhibition, will be well represented in the next.

Mr. HERBERT WRIGHT said: I am not rising to give you an address in regard to the cultivation of rubber or the testing of it, as this is hardly a fitting occasion for such a discourse. I rise merely as representing the proprietors of *The India-Rubber Journal*, and I think I may also say of *Grenier's Rubber News*, in the absence of Mr. Grenier. In the first place I wish to express our sincere congratulations to the Chairman and Directors of the Sungei Kapar Rubber Company, and also to the Manager, Mr. Brock, in whose entry the exhibits were sent. I think, as the Chairman has stated, it is a very remarkable fact that the judges, under quite different conditions, should have arrived at the same conclusion, viz., that a given sample of rubber among the many others was really the best sent in. I don't know how technologists will now be able to argue against the "rule of thumb," which they have always told us was so characteristic in the past. So far as *The India-Rubber Journal* Shield is concerned, our object was to find out what in the opinion of the judges constituted good plantation Para rubber. We have now got their judgment, and we hope to be able to give wide publicity to those points which the judges advocate, to be imitated by other planters in the Middle East. We are most anxious not only to maintain a uniform standard, but wish to improve the quality of the material which is being sent, as we firmly believe it is still open to such improvements in the very near future. I think it is very pleasing to reflect that in connection with this competition entries were received from practically every country in the Middle East. I am sorry that owing to some little delay other exhibitors from Sumatra were not able to take part in the competition, but I think perhaps they will be more attentive to dates in the future, and will see that there is better competition from the Dutch East Indies. As you are aware, all these samples have been submitted, not only to brokers, but to technologists and manufacturing firms, and I think I am right in saying this is the first occasion when an award has been deferred until it had been subjected to such minute examination. I hope that policy of having samples properly tested, not only by brokers, but by technologists and manufacturers, will be a principle others will keep in view when deciding

upon matters of so serious importance. It is pleasing to see that practically all the companies among the runners-up for the prizes are among the best known companies in London. You will notice that in point of number of the six companies given there, Malay comes first. I am very glad that Ceylon gets a little show in the exhibits from Sirinwasa and Culloden estates. I may add this competition has been a very keen one, and throughout there has been maintained good feeling. It is very satisfactory to see around this table gentlemen who were among the competitors, here to welcome the representative of the Sungei Kapar Rubber Company. I can tell you that certain manufacturers who to my knowledge have been keeping apart from the plantation Para market, have been following this competition with unusual interest, and I sincerely hope that this interest will be reflected in higher prices at the regular auctions for those who have gained first-class positions in the competitions. Not only have the manufacturers been paying attention to this competition, but to my surprise on reaching the office on Monday morning, I found a gentleman who was returning to Malay, he being an old planter there, who was desirous of taking back with him a sample of Sungei Kapar rubber, in order that he might imitate it. I should like to express our appreciation of the services which have been rendered by the various judges, manufacturers, very busy men ; technologists, equally busy men ; and brokers, who have given their time and experience so willingly and so freely. I also wish to thank Mr. Staines Manders for the attention he has devoted to these competitions. I cannot imagine any organised competition which could have gone off so well, and the success of this is largely due to Mr. Staines Manders.

Sir Henry Blake then presented *The India-Rubber Journal* Shield and the *Grenier's Rubber News* Silver Trophy to Mr. A. Gordon Dickson, representing the Sungei Kapar Rubber Company, Ltd.

Mr. Gordon Dickson said : It gives me considerable pleasure to attend this function to-day. We are taught that " 'Tis more blessed to give than to receive," but I think something of the old Adam in us makes it very pleasant to get something for nothing. On behalf of the Sungei Kapar Company I should like to thank very heartily both donors of these handsome trophies, for the public spirit they have shown in offering them for competition. (Hear, hear.) It has engendered a very healthy spirit of competition throughout the rubber-producing companies in the East, and I am sure it is a step in the direction we all wish to take, namely, the getting of our rubber home in the most marketable and satisfactory form. (Applause.)

Mr. R. K. Magor, Chairman of the Rubber Growers' Association, proposed a vote of thanks to Sir Henry Blake for presiding and presenting the trophies, which was heartily accorded.

Sir Henry Blake said he hardly deserved a vote of thanks, for it was always a pleasure to him to meet members of the Rubber Growers' Association.

Press Department.

This was under the management of Mr. Gerald Fitz-Gibbon, and the Directors wish to place on record their appreciation of his services.

The President's Trophy.

JUDGES' REPORT.

The jury appointed to consider the "President's Trophy" in connection with the International Rubber Exhibition met on July 13th at the Royal Agricultural Hall. The details relating to the award as they appear on page 520 of the Official Guide, were carefully considered one by one. It was ultimately decided that the prize should go to the "manufacturer showing the greatest variety of articles made from rubber." Each member of the Committee was requested to write on a slip of paper the exhibit which, in his opinion, should receive the Trophy. On opening the slips it was found that the meeting was unanimous in giving the award to the

HARBURG & VIENNA INDIA-RUBBER CO., Harburg-on-Elbe.

Note.—The Judges consulted Sir Henry Blake, and he endorsed their opinion.

The Rubber Growers' Association (London) Medals.

These Medals are 13 in number, and the samples which have entered for the competitions are divided into four classes, a Gold, a Silver, and a Bronze Medal, with a Certificate, being offered for each class. In addition to this, a special Gold Medal is awarded for the best all-round sample in the Exhibition.

The Medal was designed by Mr. Gilbert Bayes, the well-known sculptor, who is designing the Great Seal of England. The design of the face of the Medal is a native tapping a tree. The design is characterised by extreme delicacy.

There is a feature of interest about the Diploma of the Rubber Growers' Association, in that the Diploma was designed and the names of the winners engrossed thereon by a lady interested as a shareholder in several rubber companies, without cost to the Association.

Fifty-six samples, weighing 1 cwt., arrived in time for these competitions, and they were judged by a jury of 12.

AWARDS.

A Special Gold Medal for the best all-round sample of rubber in the Exhibition is awarded to the Associacao Commerciel do Amazonas-Manaos, Brazil, for the 385 bolochs of fine hard Para.

The Highland and Lowlands Para Rubber Co., Ltd. (Federated Malay States), were awarded a Gold Medal and Diploma in Class 1; a Gold Medal and Diploma in Class 2; and a Diploma in Class 3.

A Gold Medal and Diploma in Class 1 to the Sunnygama (Ceylon) Tea Estates Co. This sample was bracketed equally with one from the Highlands and Lowlands Co.

A Gold Medal and Diploma in Class 4 to the Galphele Tea and Rubber Estates, Ltd. (Ceylon).

A Silver Medal and Diploma in Class 1 to the Selangor Rubber Co., Ltd. (Federated Malay States).

A Silver Medal and Diploma in Class 2 to the Tremelbye Rubber Co., Ltd. (Federated Malay States).

Silver Medal and Diploma in Class 3 to the Seafield Rubber Co., Ltd. (Federated Malay States).

A Bronze Medal and Diploma in Class 1 to the St. George Rubber Estates, Ltd. (Ceylon).

A Bronze Medal and Diploma in Class 2 to the Bukit Rajah Rubber Co., Ltd. (Federated Malay States).

A Bronze Medal and Diploma to Batu Caves Rubber Co., Ltd., in Class 3. (Federated Malay States).

A Diploma is also awarded by the Rubber Growers' Association to the sister Association at Antwerp, *i.e.*, the Association des Planteurs de Caoutchouc, as a souvenir of the Exhibition.

The exhibits of the following companies were

HIGHLY COMMENDED:

Class 1. Sumatra Para Rubber Plantations, Ltd. (East Coast of Sumatra).
Federated Malay States Rubber Co., Ltd.

COMMENDED.

Class 1. Sumatra Para Rubber Plantations, Ltd.
Rosehaugh Tea and Rubber Co., Ltd. (Ceylon).
Ceylon Tea Plantations Co., Ltd.
Doranakande Rubber Estates, Ltd. (Ceylon).
Kintyre Tea Estates Co., Ltd. (Ceylon).
Class 2. Rembia Rubber Estates, Ltd. (British Malaya).
Class 3. Gikiyanakande Estate (Ceylon).

The Gold Medals of the Kolonial Wirtschaftliches Komitee, Berlin.

Dr. Fickendey (Victoria), Kicksia Rubber: Honourable Mention.
Dr. C. Christy, London, ditto: Specially Commended.
Weber & Schaer, Hamburg, ditto:
Mkumbi Rubber Plantations, London, Ltd., *Manihot Glaziovii*: Highly Commended.
V. Lommel, Amani, ditto: Highly Commended.
Herr Preuss, *Ficus Elastica*: Specially Commended.

The following is the substance of the Judges' report:—

Ficus Elastica.—Only one exhibit entered; the conditions of the competition were not fulfilled. The specimens being of high quality, the Judges recommend the exhibit be specially commended.

Kicksia Rubber.—Three exhibits. Only one competitor had fulfilled all the conditions, and the Judges did not consider the rubber exhibits in this case sufficiently good for the award of a Gold Medal.

The Judges recommend that Dr. Christy should be specially commended for the suggestions in his book on Kicksia Rubber.

Dr. Fickendey should receive honourable mention for his experimental work.

Manihot.—Two exhibits only, in neither of which are the conditions of the competition fulfilled. Some of the small samples from the Amani experiment station show good progress, and the Judges recommend that the exhibits be highly commended.

Silver Bowl.

Presented by the Association des Planteurs de Caoutchouc:

Société de Cultures Nieuw-Tjisalak, Nieuw-Tjisalak, Residentie Bantam, Java.

The West India Committee Awards.

Silver Cup for the finest specimen of plantation rubber: Mr. W. Hodgson, Plantation Noitgedacht, British Guiana.

Silver Cup for the finest specimen of balata: The Consolidated Rubber and Balata Estates, Ltd., British Guiana.

Silver Cup for the best exhibit by a West Indian Botanic Department: The Department of Agriculture of Trinidad and Tobago.

Silver Cup for the best West Indian comprehensive exhibit: The Permanent Exhibition Committee of Trinidad and Tobago.

"The India-Rubber World" (New York) Trophy.

The following is the substance of the Judges' Report:—

The entries for this competition are remarkably few in number, and are as follows:

1. Ernest W. Graves (Mexico): combined excision and incision in one instrument.
2. Harry S. Smith (Tobago): A combined chisel with thin blade 1½ inches wide and sliding weight on the handle.
3. C. de E. Collin (Ceylon): Thin blade ½ inch wide.
4. Maxwell Riddle (New York): A pricker.
5. Fr. Gierlings (Java): Excision and incision blades at opposite ends of handle.
6. C. O. Lilliesköld (Mexico): No instrument submitted to the Judges.
7. J. W. Conggryjp (Surinam): An excision blade.

In addition to the tapping knives, other instruments, such as collecting cups, a sprayer, a ladder, and methods of tapping, formed part of the entries in some cases.

The conditions of the competition made it necessary that the Judges should be satisfied by strong and complete evidence of marked superiority from the planter's point of view, before awarding so valuable a prize to one of the present competitors, and, while commending the tapping tool in No. 2 entry, we are of opinion that the evidence in its favour, though considerable, has not been obtained for a sufficient length of time to justify us in making the award.

We have had to consider the respective merits and defects of the incision methods of tapping, as both were included in the systems submitted to us, and after very careful consideration we are unanimously

in favour of incision with very thin blades as giving a satisfactory yield of latex and being least likely to cause future and permanent injury to the trees. This evidence can only be obtained by experimenting over a series of years. Some simple and inexpensive method of collecting the latex has yet to be devised in connection with the incision tapping instrument commended.

The ladder in No. 1 entry is likely to prove very useful for rubber tapping generally if it can be supplied at a reasonable cost.

We suggest that this valuable cup be held over for competition at some future date, and that the conditions of the competition be not confined to the "extraction" of the latex.

The Judges are of opinion that complete data should be submitted as to the yield and cost of extraction and collection over a period of at least two years, and the condition of the trees at the end of that period be shown by photographs.

The "India-Rubber Journal" Shield

and

"Grenier's Rubber News" Trophy.

Methods adopted for judging samples.

At the meeting of the Judges, held on the 14th June, at the Exhibition Offices, the following scheme of judging and methods of testing were approved :—

1. 5 lbs. of each sample is to be taken for examination.

2. In the judging of the samples the following attributes of the sample will be considered : (a) colour, (b) chemical purity, (c) commercial value of the vulcanized article.

3. The maximum number of marks obtainable by any sample will be 100. Of these a maximum of 10 marks will be allowed for colour, 20 marks for chemical purity, and 70 marks for practical value of material as determined by vulcanization and testing of the vulcanite products.

4. With regard to the vulcanization tests, it was agreed that it was essential that the whole batch of samples in each competition should be tested by one and the same judge, otherwise it would not be practicable to get absolutely comparable results. For these tests one manufacturer took the whole of the samples for the "India-Rubber Journal" Shield, and another the whole of those for "Grenier's Rubber News" Trophy.

Methods of Examination.

1. *Colour.* Judges will be at liberty to use their discretion in regard to the judging of colour.

2. *Chemical Purity.* It was determined that the following constituents should be estimated : moisture, resin, nitrogen (as proteid) and ash. It was also determined that no marks should be deducted from samples containing not more than 1 per cent. of moisture, 2 per cent. of resin, 2 per cent. of proteid and 0·5 per cent. of ash. If the percentage of any constituent is beyond these figures the excess will be deducted from the total of 20 marks. For instance, a sample containing 2 per cent. of moisture, 3 per cent. of resin, 3 per cent. of proteid, and 1·5 per cent. of ash would have deducted 1 mark for moisture, 1 mark for resin, 1

mark for proteid and 1 mark for ash. The marks shall be calculated to the nearest half-mark. Any sample losing the full 20 marks shall be disqualified.

The following *methods of chemical analysis* were determined on:

(a) Moisture. The moisture shall be taken as the difference between the weights of the rubber before the weights of the rubber before and after extraction after allowing for the resin extracted. (See resin). The weight of the extracted sample shall be determined by drying in a steam oven until the weight no longer decreases.

(b) Resin. Three grams of the rubber shall be extracted for six hours in a Soxhlet extractor.

(c) Proteid (Nitrogen). The determination shall be made on one gram by the Kjeldahl process.

(d) Ash. The determination shall be made on one gram of the material. The material shall be charred and then burned to a white ash at as low a temperature as possible.

Vulcanization Tests.—The methods of mixing, curing and testing shall be left to the discretion of the individual judge carrying out the tests. Samples shall be washed if necessary.

NOTE.—The maximum points were as follows:—

COLOUR.	CHEMICAL TEST.	VULCANISING AND MANUFACTURING TEST.
10	20	70

The following principle was carried out in connection with the awarding of the points:—

The Committee took five pounds of each rubber; each sample was given a special key number, which did not correspond with the catalogue number. For colour, the samples were inspected and points given under the key number. After the judging for colour was completed, half a pound was cut from each five pound sample. Then each half and four-and-a-half pound sample was keyed and the former sent to chemists and the latter (the larger portion) to manufacturers.

In each Competition, except for colour, a separate set of judges acted, amongst them being some of the leading manufacturers and chemists of Great Britain.

"India Rubber Journal" (London).

Hundred Guinea Shield.

For the best sample of Plantation Para Rubber.

The samples sent in for competition were put through a very thorough and severe test, as the foregoing methods will show, by some of the leading manufacturers and chemists of Great Britain. Each report was sent in to the Exhibition offices in a sealed envelope and opened at the meeting of the judges on Friday, 8th September. These reports were then compared, with the following results:—That the judges awarded the Shield to the

SUNGEI KAPAR RUBBER CO., LTD., SELANGOR (F.M.S.),

whose rubber secured 96·5 points.

The following received over 90 but under 96 points, and were highly commended by the judges :—

Siriniwasa Estate (W. A. de Silva), Kalani Valley, Ceylon	94 points
Tremelbye Rubber Co., Ltd., Klang, F.M.S.	93·5 points
Bukit Rajah Rubber Co., Ltd., Klang, F.M.S.	93·5 points
Highlands and Lowlands Para Rubber Co., Ltd., Selangor, F.M.S.	92·5 points
Culloden Estate (C. O. Macadam), Neboda, Ceylon ...	92 points
Klanang Produce Co., Ltd., Selangor, F.M.S.	90 points

The same method of judging was carried out in connection with the samples of Rubber sent in for competition for

"Grenier's Rubber News" (F.M.S.)

Fifty Guinea Silver Trophy.

For the best sample of commercial Plantation Rubber grown in the Federated Malay States or Ceylon.

At a meeting of judges held on Tuesday, 12th September, they awarded the Trophy to the

SUNGEI KAPAR RUBBER CO., LTD., SELANGOR (F.M.S.),

whose rubber secured $98\frac{1}{2}$ points. One other rubber secured over 90 points and was highly commended, that of the

TREMELBYE RUBBER CO., LTD., OF KLANG, F.M.S.,

which gained 92 points.

Each sample sent in for competition was given a key number, by which it was known to the judges, and was totally different from the Catalogue number.

The following figures are selected at random from the Judge's Awards in the *India Rubber Journal* (London), Shield, and *Grenier's Rubber News* (*F.M.S.*) Silver Trophy Competitions. They are the points of some of the competitors who did not receive 90 or over, and are published to show the variation in the number of points.

TESTS.

Colour.	Chemical.	Vulcanisation.	Colour.	Chemical.	Vulcanisation.
2	17	65	3	17·5	65
8	18·5	60	4	20	60
1	18·5	65	2	18	49
7	20	45	8	18·5	46
9	19	60	2	17	65
8	18	45	1	19	56
4	19·5	45	7	18·5	45
8	20	45	9	19	51
9	19	50	9	17·5	40
0	16	55	5	16·5	38
0	10	65	5	18	41
0	17·5	65	9·5	17·5	43
10	19	56	7	18	43
7	18	45	4	18	67
8	18·5	60	2	18	60
7	18	60	3	18·5	44
3	17·5	60	6	19	46
2	18	60	8	6·5	53

SYNTHETIC RUBBER.

Tests in the manufacture of this article were undertaken at the recent International Rubber Exhibition, but it is unlikely that, in the near future, it will be a serious competitor to indigenous or plantation rubber.

Eds.

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